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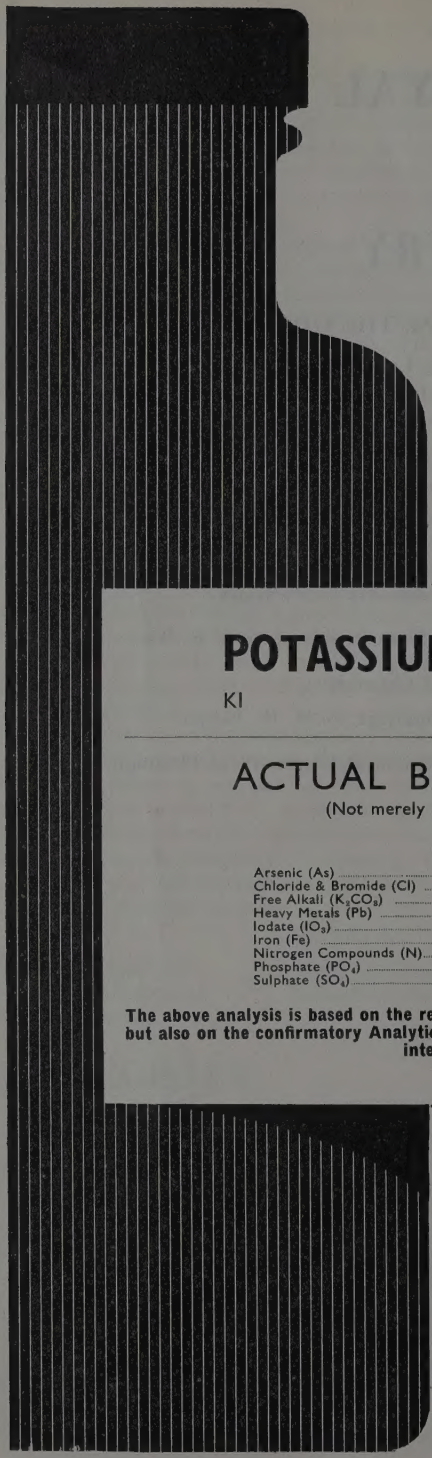

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Iodate (IO_3)	No reaction
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THE ROYAL SOCIETY TERCENTENARY CELEBRATIONS

The programme of events in celebration of the Tercentenary of The Royal Society's Foundation covered the period 18–26 July. On 18 July the President and Vice-Presidents of the Society were in attendance at Burlington House to receive formal congratulatory addresses, and Mr E. LeQ. Herbert, as President of the Institute, presented a message on behalf of the Council, Fellows and Associates. The addresses were exhibited at a Conversazione on 23 July.

The Formal Opening took place at the Royal Albert Hall on 19 July, amid a colourful array of international academic dress, such as is seldom seen. The removal of the Society's mace was the signal that the Royal Party had arrived, and The Queen then entered the Hall, accompanied by The Duke of Edinburgh and the King and Queen of Sweden. The Queen having opened the proceedings, Sir Cyril Hinshelwood, O.M., P.R.S., called on representatives of the University of Bologna (founded in the eleventh century), the Academy of Sciences of France (1666), and of the Australian Academy of Science (1954), who read special messages of congratulation. His Majesty King Gustav VI Adolf of Sweden was then formally admitted to the Fellowship of the Royal Society. After The Queen left the Hall, the Society's mace was carried in, and Sir Cyril delivered the Tercentenary Address.

During this impressive occasion, music was provided by Dr G. Thalben-Ball (organ) and the band and trumpeters of the Royal Military School of Music; Sir Arthur Bliss, Master of the Queen's Musick, conducted the performance of a new composition, 'Salute to the Royal Society on the Occasion of its Tercentenary,' for organ, brass, timpani and cymbals.

Wednesday was devoted largely to a programme of Tercentenary Lectures illustrating key themes of great contemporary importance, and Thursday was spent at Oxford, where there was a special Honorary Degree Ceremony at the University, and a garden party at Wadham College.

On 22 July the Queen Mother, as Chancellor of the University of London, conferred a number of honorary degrees at a ceremony in the University of London. In the afternoon three new films were shown at the Royal Festival Hall, the Royal Dutch/Shell Group of Companies being the host. First the Opening Ceremony was recalled in a film made by the Newsreel cameras, and this was followed by 'The Revealing Eye,' an album of phenomena that escape the human eye but have been recorded on film. The main item, named after a phrase of Francis Bacon, 'A Light in Nature,' bravely tackled a theme of great magnitude and complexity—world science at the frontiers of knowledge, together with an impression of its heritage derived from three centuries of endeavour and attainment.

In the evening receptions were given by the Lord Mayor and Corporation at Guildhall and by the 12 great City Companies in the Hall of the Mercers' Company.

The morning of 23 July was again devoted to lectures and in the evening, at a Conversazione at Burlington House, many historic treasures were on view; these included the first charter granted by Charles II in 1662, the mace presented by the King in the following year, the Charter Book containing the signatures of the Royal Patrons and the Fellows, and the minutes of the first meeting on 28 November, 1660. Addresses of congratulation were on view in the Library. The main galleries of the Royal Academy of Arts in the adjacent building were open to those taking part in the celebrations who wished to see the Summer Exhibition, and the Tercentenary Exhibition of the Royal Society was also housed there. There were 15 major scientific exhibits of extremely high standard and varying from calculating machines and radioastronomy to refined chemical separation and microbial genetics. Several portraits of early Fellows were on view in the Diploma Galleries. The rooms occupied by other Societies in Burlington House were also on view—The Linnean Society, The Royal Astronomical Society, the Society of Antiquaries, The Geological Society and The Chemical Society.

The rest of the programme consisted mainly of visits to places of scientific and cultural interest in London and the provinces, concluding with the Tercentenary Dinner at Grosvenor House on 26 July attended by the Prime Minister and Lady Dorothy Macmillan and a large number of other British and foreign guests.

On this occasion it would be fitting to emphasize one aspect of the work carried out by Fellows of the Royal Society that has not been mentioned, so far as we are aware, namely the honorary work they undertake for professional scientific organizations. Many of those listed below have rendered signal service not only to their special fields of science but also to the profession of chemistry in its widest sense.

Of the 12 *Honorary Fellows* of the Institute, seven are Fellows of the Royal Society, namely—

H.R.H. The Duke of Edinburgh, K.G., K.T.

Lord Adrian, O.M., NOBEL LAUREATE; Sir Edward Appleton, G.B.E., K.C.B., NOBEL LAUREATE; Sir Lawrence

Bragg, O.B.E., M.C., NOBEL LAUREATE; Sir John Cockcroft, O.M., K.C.B., C.B.E., NOBEL LAUREATE; Sir Henry Dale, O.M., G.B.E., NOBEL LAUREATE; and Sir Harold Hartley, G.C.V.O., C.B.E., M.C.

They come within the category of British subjects 'who, although they may have begun their careers as chemists, have achieved eminence in some other field, and have thereby contributed directly or indirectly to the advancement of the profession of chemistry.' Two of the other Honorary Fellows of the Institute are distinguished foreign chemists who are Honorary Foreign Members of the Royal Society, namely—

Dr J. B. Conant, HON. C.B.E.; and Prof. A. W. K. Tiselius, NOBEL LAUREATE.

The Institute is also proud to number among its *corporate members* the following 75 Fellows of the Royal Society:—

Prof. N. K. Adam; Prof. W. Baker; Prof. R. M. Barrer; Prof. F. Bergel; Prof. A. J. Birch; Prof. J. A. V. Butler; Prof. A. C. Chibnall; Prof. G. R. Clemo; Prof. E. J. Conway; Dr A. H. Cook; Dr J. W. Cook; Prof. E. G. Cox; Prof. F. S. Dainton; Prof. J. N. Davidson; Sir Charles Dodds, M.V.O.; Prof. H. J. Emeléus, C.B.E.; Sir Alexander Fleck, K.B.E.; Dr F. A. Freeth, O.B.E.; Prof. G. Gee; Sir Charles Goodeve, O.B.E.; Prof. E. A. Guggenheim; Prof. R. D. Haworth; Prof. D. H. Hey; Prof. T. P. Hilditch, C.B.E.; Sir Cyril Hinshelwood, O.M., NOBEL LAUREATE; Prof. E. L. Hirst, C.B.E.; Prof. E. D. Hughes; Sir Christopher Ingold; Prof. E. R. H. Jones; Prof. J. K. N. Jones; Dr J. Kenyon; Prof. W. O. Kermack; Prof. R. J. W. Le Fèvre; Dr E. Lester Smith; Sir Patrick Linstead, C.B.E.; Prof. H. C. Longuet-Higgins; Prof. B. Lythgoe; Dr F. G. Mann; Dr G. F. Marrian; Sir Irvine Masson, M.B.E.; Sir Harry Melville, K.C.B.; Prof. W. T. J. Morgan, C.B.E.; Prof. R. A. Morton; Prof. A. Neuberger; Prof. D. M. Newitt, M.C.; Prof. R. G. W. Norrish; Prof. R. S. Nyholm; Prof. S. Peat; Prof. G. Porter; Prof. Helen K. Porter; Mr A. R. Powell; Prof. J. A. Prescott, C.B.E.; Prof. J. H. Quastel; Prof. H. Raistrick; Prof. G. V. Raynor; Sir Eric Rideal, M.B.E.; Prof. J. M. Robertson; Sir Robert Robinson, O.M., NOBEL LAUREATE; Dr F. L. Rose, O.B.E.; Prof. T. R. Sheshadri; Sir William Slater, K.B.E.; Dr R. Spence, C.B.; Dr F. S. Spring; Prof. M. Stacey; Dr L. E. Sutton; Dr R. L. M. Synge, NOBEL LAUREATE; Sir Alexander Todd, NOBEL LAUREATE; Prof. F. C. Tompkins; Prof. E. E. Turner; Prof. A. R. J. P. Ubbelohde; Prof. R. L. Wain; Prof. T. Wallace, C.B.E., M.C.; Dr W. A. Waters; Prof. A. Wormall; and Prof. F. G. Young.

WILLIAM JAMES RUSSELL, 1830-1909

Sixth President, 1894-1897

By K. R. WEBB, B.SC., PH.D., F.R.I.C.

Chemistry Department, University of Southampton

An interesting link connects the sixth holder of our Presidential Chair with Dr Joseph Priestley (1733–1804), one of the 'founding fathers' of modern chemistry, for it was Priestley's close friend, William Russell (1740–1818)—the President's grandfather—who was partly responsible for promoting, in Birmingham, the fateful dinner of 14 July, 1791. This, it should be recalled, was held to commemorate the fall of the Bastille two years before, and to promote trade between revolutionary France and Birmingham; however, it led instead to an outbreak of 'Church and King' rioting in which both Priestley's and Russell's houses were burned to the ground by a so-called loyal mob, and which ultimately led to Priestley's departure to America in 1794.

William James Russell, the son of a banker, Thomas Pougher Russell (1775–1851), and his wife (*née* Mary Skey), was born in Gloucester on 20 May, 1830. After attending private schools—Dr Wreford's at Bristol, and later the Rev. Samuel Bache's at Birmingham—Russell entered University College London in October, 1847, and studied chemistry under Thomas Graham and A. W. Williamson. Four years later he became the first demonstrator in chemistry (under Professor E. Frankland) in the then recently founded Owens College, Manchester, and had the interesting experience of helping to plan, and superintend the building of, the first chemical laboratory—in the garden of what had formerly been Cobden's house in Quay Street, Manchester—for the College which ultimately grew into the University of Manchester.

In those days the call of Germany to youthful chemists was as siren-like as is that of America now, and in the autumn of 1853 Russell succumbed, and left Manchester for Heidelberg where, for about two years, he worked under Bunsen and took his Ph.D. on 16 December, 1854. During this time Russell doubtless became acquainted with many of the improvements in gas analysis which had been developed by Bunsen in the previous 15 or so years, and must have seen in operation Bunsen's abnormally broad thumb—of which he was very proud—and which, he asserted, could close successfully the mouth of the widest eudiometer tube without

the slightest spill of mercury! All this knowledge Russell was able to put to good use when, in 1857, he went back to University College London as an assistant to his old teacher, Williamson. Together they devised accurate and convenient apparatus for certain gasometric operations. A short paper was published by Williamson and Russell on the measurement of gases in analysis (1859), and there were later publications relating to this topic in 1864 (Williamson and Russell) and in 1868 (Russell). Russell also wrote an article on 'Gas Analysis' for Watt's *Dictionary of Chemistry*.

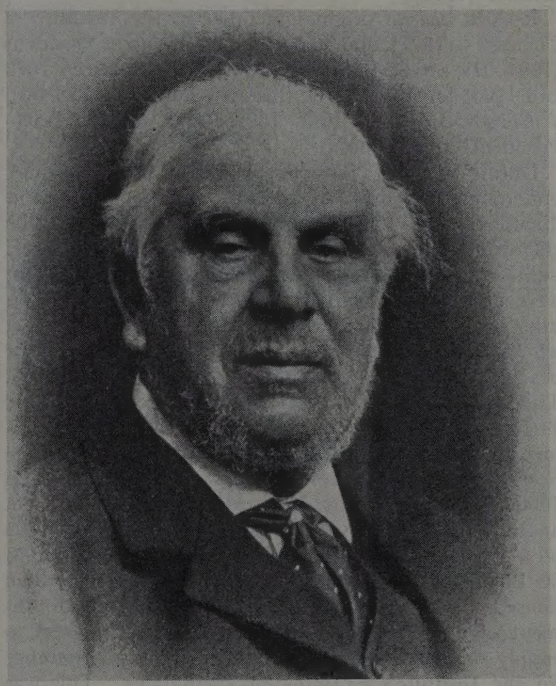
During the period 1860–1870, Russell was lecturer on natural philosophy at Bedford College, London, which had been established in 1849 for the higher education of women. Here he had the distinction of opening (in 1860) the first laboratory accessible to women students for practical science work. He retained his interest in this aspect of science teaching, being a member of the Council of Bedford College from 1878 to 1903, and chairman of it from 1887, and of the College Board of Education from 1895. One obituary writer says: 'During Dr Russell's chairmanship, the College was twice enlarged, and at the end of his term of office the necessity for still further extension had become so pressing that it was decided to start a fund to provide an entirely new building. He was an active supporter of this movement, and contributed liberally to the fund' (*Nature*, 1909, **82**, 101–102).

During the 1860s, Russell carried out some work on the determination of accurate atomic weights of cobalt and nickel, and two papers were published (1863, 1869). The values obtained for nickel were especially good for the time.

From 1868 to 1870 Russell lectured on chemistry in the Medical School of St Mary's Hospital, and, from 1870 until his retirement from active teaching in 1897, he was lecturer in chemistry at St Bartholomew's Hospital. He was chosen for this post from seven candidates and was provided with a newly built laboratory, a lecture theatre capable of holding 100 students and a preparation room. The appointment was rather different from a modern teaching post in that although Russell was a teacher in the Hospital and received fees from the Medical School, all the contents of the laboratory were his private property. Furthermore, he personally employed two demonstrators, one for his private laboratory and the other for School work. When Russell resigned in 1897, after 26 years as lecturer, he presented all the apparatus, worth at least £300, to the Medical School. Russell 'modified the teaching of chemistry to suit the curriculum of medical students, and was very popular as a lecturer.'

Among his scientific researches of this period, those on absorption spectroscopy should receive special mention. In this field, the work of Russell and his assistant, W. Lapraik, on the absorption spectra of colourless liquids was of a pioneer character, and together with that of Abney and of Walter Noel Hartley, provided a foundation upon which later important developments were built by other investigators. Russell's studies appeared in the early 1880s.

Another piece of pioneer work was Russell's investigation of London fog—one of the very earliest examples of work on atmospheric pollution. He published several papers in this field between 1881 and 1891. These showed the increase of sulphuric and hydrochloric acids, and particularly of carbon dioxide, in the air during dull and especially during foggy weather. He was particularly active in this field from 1881 to 1886. A good account of this work is given by J. R. Brown and J. L. Thornton (*Ann. Sci.*, 1955, **11**, 331–336), together with a complete bibliography of Russell's scientific writings from 1855 to 1908).



Other later studies dealt with the effects of convection currents of air arising from heated bodies on the deposition of dust in their vicinity (1903), and some interesting observations on the effects (in darkness) of certain metals and other substances on photographic plates (1897–1908), which were traced by Russell to the production of traces of hydrogen peroxide. The earlier stages of this work were discussed in his Bakerian Lecture to the Royal Society in 1898.

Russell joined the Chemical Society on 3 March, 1851, and enjoyed some 58 years of membership, filling most offices at some time or other. He was

Secretary (1873–75), Treasurer (1875–89) and President (1889–91) and a permanent Vice-President from 1891 until his death in 1909. During the celebrations which marked the jubilee year of the Chemical Society (1891), Russell, as President, was necessarily involved in all the official proceedings, and as one writer says: 'all who were present must have been struck by the admirable manner in which he acquitted himself. He had to make many speeches, long or short, and they were always simple and appropriate. Without wasting words, or any apparent striving after effect, he managed every time to say exactly what wanted saying' (*Nature*, 1909, **82**, 101–102).

Russell was elected to the Royal Society in 1872, twice served on its Council, and was a Vice-President in 1897–99, during which time he was also Bakerian lecturer (1898).

Russell was an original member of the Institute of Chemistry (1877), and apart from his period as President (1894–97), served in various other offices between 1878 and 1904; for instance, he was an Examiner (1878–80), a Censor (1885–90 and 1894–1904), and a Vice-President (1897–1900).

During Russell's Presidency, the Institute was steadily undergoing development and consolidation in various directions, and the relations of the members of the chemical profession to one another and to the general public were becoming better defined. These relations were undoubtedly helped, anyway from the Institute's side, by a conference held on 23 November, 1894, at which a code of professional conduct and ethics for practising chemists was discussed by Professor W. A. Tilden, Dr Russell's immediate predecessor in the Presidency. Another development was the appointment of Mr R. B. Pilcher, in 1895, as the first full-time Secretary of the Institute; he was afterwards (from 1900) for some 45 years, Registrar and Secretary. Yet another helpful innovation was the provision in 1895 of a writing room for members, on the first floor at 30 Bloomsbury Square, where the Institute was then housed. This was followed in 1897 by the establishment of a useful working library, partly designed to supply standard chemical and allied works of reference for the Institute's Examination candidates. This was done on the initiative of Otto Hehner, an Examiner and a noted practical chemist of the time, who presented some £40 worth of carefully selected standard works to form the nucleus of the collection, much of which was housed in the writing room. At this period, too, the Council was anxious to make available a suitable qualification for members of the Institute intending to practise as Public Analysts, and some preliminary steps were taken. This matter, however, was only brought to a successful conclusion during the reign of Dr Thomas Stevenson, who was Russell's successor. Other interesting events of Russell's Presidency were a dinner, held on 25 May, 1894, at which Lord Kelvin, as President of the Royal Society, was present, and a soirée for Fellows and Associates on 5 June, 1896, when the numerous distinguished guests included Mendeléeff, who was then visiting London.

Of Russell's personality, one who seems to have known him well said: 'In manner, Russell was quiet and entirely free from anything approaching self-advertisement, but he was genial and hearty with his friends, and was gifted with a sympathetic laugh that it was always refreshing to hear' (*Nature*, 1909, **82**, *loc. cit.*). As some indication, both qualitative and quantitative, of the estimate formed of him by his fellows (the same writer continues): 'it may not be out of place to mention that, as a young man, he was the first secretary, treasurer, and keeper of the archives of the "B" club—originally a society of young chemists which grew out of Section B of the British Association, first took definite shape at the Oxford meeting in 1860, and kept itself alive between the meetings of the Association by consuming monthly beef-steak puddings at the "Cheshire Cheese"—and that, in later life, he was elected to serve on the committee of the Athenaeum Club.' Although personally modest, Russell upheld very positively the dignity of the chemical profession. It is recalled that he arrived for meetings at the Institute 'in a very well equipped carriage and pair, with liveried coachman and footman.' He also, as a good chemist, 'believed in the importance of careful observation; he would casually dip a finger in a substance to taste it, and then invite a student to do the same as he had done. Woe betide the youth who had not noticed that Russell had used a different finger to touch his tongue!' (*J. R. Inst. Chem.*, 1954, **78**, 112).

In 1862 Russell married Fanny, daughter of Abraham Follett Osler, F.R.S., a well known glass manufacturer of Birmingham. He was survived by a son, and by a daughter who married the chemist, Dr A. Scott, F.R.S. Always fond of the country and of natural beauty, Russell had for many years (1882–97) a house called Scorhill, near Chagford on the edge of Dartmoor. This was additional to his London home at 34 Upper Hamilton Terrace, N.W. Scorhill was later replaced by a more accessible house, St Ives, near Ringwood, Hampshire, in a delightful sylvan setting. There he died, aged almost 80, on 12 November, 1909, just over half a century ago.

PHYSICS IN THE SERVICE OF CHEMISTRY

HIGH-VACUUM TECHNIQUES

By M. W. ROBERTS, PH.D., A.R.I.C.*
National Chemical Laboratory, Teddington

The applications of high-vacuum techniques in chemistry are so wide and diverse that a comprehensive treatment would entail encroaching on almost every field of physical chemistry and on many fields in both inorganic and organic chemistry. This article, however, will be concerned mainly with the more recent developments in technique and the fundamental concepts that have arisen as a result of the availability of high vacuum.

Before the development of the carbon filament lamp, interest in low pressures was almost entirely centred around experiments appertaining to the properties of electric discharges in gases at pressures around 10^{-1} mm Hg. To obtain such pressures a piston pump was generally used and lower pressures, when necessary, were obtained by means of the hand-operated Toepler pump. It was the invention of the incandescent lamp that provided the real driving force for the development of high-vacuum equipment. The work of Gaede[1] was of considerable significance in the development of the technique, and in 1915 pressures of the order of 10^{-6} mm Hg were first obtained by Langmuir[2]. Nevertheless, even in the middle thirties vacua of 10^{-6} mm Hg were still regarded as academic curiosities. The last 25 years, however, have seen a direct transfer to industry of inventions, techniques and processes that were purely academic in origin.

It has been conventional until more recently to regard a 'high vacuum' as the ultimate state attainable by pumping equipment, *i.e.* a pressure of around 10^{-6} mm Hg. However, owing to very considerable advances in the last decade a new vacuum technology has developed which makes it possible to achieve pressures as low as 10^{-11} mm Hg. Such a technology, designated ultra-high vacuum, has made possible considerable fundamental advances in both physics and chemistry. The technique is at present in its early stages; nevertheless its impact has already been felt, especially in the field of gas–metal reactions.

THE PRODUCTION AND MEASUREMENT OF LOW PRESSURES

In attaining or measuring pressures of the order of 10^{-6} mm Hg no special techniques are required. For quantitative studies, however, it is not only necessary to attain such low pressures but also to maintain these pressures for long periods of time when the system is disconnected from the pumps. A leak rate of 10^{-5} mm per hour, in a conventional high vacuum apparatus two litres in volume, may be regarded as satisfactory.

The gas discharge method is the most commonly used leak detector. The mass spectrometer is the most sensitive but, in general, such an instrument is not available in most high-vacuum laboratories. Both the Penning and Ionization Gauges depend for their action on the fact that different gases have different ionization efficiencies from that of air. Thus by using a probe gas with characteristics very different from those of air, changes can be observed in the instrument reading when the probe gas impinges on the leak. Pirani and thermocouple gauges can be used in the same way but are much less sensitive. The efficiency of various probe gases has been measured[3] by allowing the probe gas to impinge on a leak in a system containing small air pressure and noting the apparent change in pressure. The order of decreasing efficacy was butane, diethylether, carbon dioxide and carbon tetrachloride.

The following factors have to be considered in the construction of a high-vacuum apparatus if leak rate is to be 10^{-5} mm per hour or less:

1. The vapour pressure of any stopcock grease;
2. Desorption of occluded gas from stopcock grease;
3. The desorption of gases and vapours from the glass walls of the apparatus;
4. The possibility of 'virtual leaks', *i.e.* a slow desorption of condensed gas or vapours from refrigerated traps;
5. Prevention of back-streaming of pump oil from the rotary pump into the apparatus.

Gas manipulation may be effected by mercury 'cut-offs', which would not give any trouble from grease, a liquid nitrogen trap (or traps) being used to protect the reaction vessel from mercury vapour. At liquid nitrogen temperature (−195°C) the vapour pressure of mercury is around 10^{-30} mm. Blears[4] has shown mass-spectrometrically that even in a well-baked system mercury vapour is present to the extent of 10^{10}–10^{14} times that expected in a system containing a liquid nitrogen trap. It has recently been suggested that 'cut-offs' for gas manipulation may incorporate other

* Now Lecturer in Physical Chemistry, Queen's University, Belfast.

metals of low melting point and of low vapour pressure in place of mercury. Two such metals are indium and gallium, their respective melting points being 30°C and 157°C and their vapour pressures less than 10^{-7} mm Hg at the melting point. These metals have the disadvantage of being very costly and a cut-off employing Wood's alloy has been described[5]. In an investigation of the interaction of sulphur vapour with carbon surfaces Sykes and White[6] made use of a magnetically operated tap. This was heated to above 200°C in order to prevent condensation of sulphur. Such a tap is, however, only applicable for experiments of relatively short duration because the conductance of the tap is relatively high when in the closed position at pressures of around 10^{-2} mm Hg.

The desorption of gases and vapours from the glass walls of apparatus is an important aspect of high-vacuum technique. Sherwood[7] showed that dry air could be removed very rapidly from glass at ordinary temperatures, whereas for moist air or air mixed with carbon dioxide (important products in the degassing of glass) the rate of desorption at room temperature was negligible. On heating to between 300°C and 400°C practically all this gas could be removed within a few minutes.

Hydrocarbon vapours, either from an oil diffusion pump or from a rotary pump, are present in a conventional high-vacuum system[4]. It is therefore advisable to place an active carbon trap between the oil pump and the system being outgassed when very low pressures are required, though such a trap would decrease the pumping speed. Alpert[8] introduced the use of thin corrugated copper in liquid nitrogen traps for ultra-high-vacuum systems. This trap was originally conceived as a means of reducing the desorption of gas from the upper regions of a trap as the liquid nitrogen fell but it was found that such copper traps were remarkably effective in reducing the back-streaming of pump oil which seems to limit the ultimate vacuum attainable with oil diffusion pumps. This baffle action of a copper trap was found to persist with good efficiency even when the trap was uncooled.

Thus an all-glass grease-free apparatus capable of being heated to around 400°C, utilizing cut-offs for gas manipulation, liquid nitrogen traps for protection of the reaction vessel, and a copper baffle after the diffusion pump, would eliminate the contaminants likely to influence any reaction being studied.

In the pressure range 10^{-1} to 10^{-6} mm Hg the McLeod gauge is most widely used. It is an absolute instrument but suffers from the disadvantage that it cannot measure the pressure of an easily condensable gas. This disadvantage can, in some cases, be overcome by jacketing the gauge at an elevated temperature. The McLeod gauge measures pressures as low as 10^{-4} mm Hg to within a few per cent, but below this pressure its accuracy becomes appreciably smaller. A recent adaptation[9] of the McLeod gauge enables pressures as low as 10^{-7} mm Hg to be measured accurately. This is effected by sealing a thermistor bead into the closed end of the capillary of the gauge; the thermistor acts as a thermal conductivity manometer of the Pirani type and after calibration may be used in the range $1–10^{-3}$ mm Hg (without compressing the gas in the McLeod gauge). Pressures in the lower range are measured by compressing the gas in the McLeod bulb into a small chamber containing the thermistor so that the pressure in this chamber is within the range $1–10^{-3}$ mm. This latter pressure is then determined by measuring the thermistor resistance, which enables the original very low pressure to be calculated from Boyle's law, knowing the volumes of the bulb and chamber. The gauge is therefore an absolute one in the pressure range 10^{-5} to 10^{-7} mm, in contrast to an ionization gauge, which is normally used. Calibration of an ionization gauge in this range is an extrapolation of that determined by comparison with a McLeod gauge in the 10^{-3} to 10^{-5} mm range.

In principle the ion gauge is a hot filament triode; it is shown diagrammatically in Fig. 1. When free

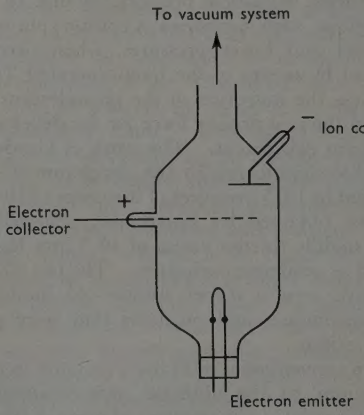


FIG. 1

of gas, with normal potentials on the electrodes, the ion current is extremely small. If a gas is present, however, the gas molecules are ionized as a result of collisions with the electron stream and the positive ions formed are collected on the negative grid. The grid current per unit electron current can thus be used to measure the pressure of the gas.

Although a Knudsen gauge is designated as one capable of measuring pressures as low as 10^{-7} or 10^{-8} mm Hg, Yarwood[10] is of the opinion that such an instrument, even after thorough degassing at 400°C, is not reliable below 10^{-6} mm Hg.

That pressures as low as 10^{-10} mm Hg could be obtained was viewed with considerable scepticism until more recent years when techniques became available to measure such pressures. The ionization gauge is not

capable of indicating pressures below 10^{-8} mm Hg, but in 1948 Apker[11] suggested a method for using an ion gauge to indicate pressures less than this value. The technique involves the incorporation of an auxiliary tungsten filament within the ionization gauge. By flashing to a temperature around 2000°K the filament can be cleaned of any adsorbed gas. After a time, t, during which it is maintained at room temperature, the filament is re-flashed at 2000°K. This second flashing suddenly desorbs the molecules adsorbed on the filament during t and this sudden burst of gas registers as a change in the ion-gauge reading. This pressure burst increases at first linearly with t, but for large t values the pressure becomes constant on flashing. This levelling-off point is taken to correspond to the time when the flashed filament has adsorbed a monolayer of gas. Since the rate at which molecules hit a surface at a given temperature and pressure and the number of molecules required to form a monolayer on the filament can both be estimated, then the time required to form a monolayer on the filament can be calculated. Thus it is possible to estimate the pressure in a vacuum system even though it lies well below the measuring range of the ionization gauge.

The failure of the ionization gauge to measure pressures lower than 10^{-8} mm Hg was attributed by Nottingham[12] to a residual X-ray current which was independent of the pressure. Therefore to extend the low pressure range of such a gauge this X-ray current had to be reduced. This was achieved in the Bayard–Alpert[13] design, which also has a minimum of metallic surface so that it can be readily degassed. In addition to the X-ray effect, an ion gauge has limitations resulting from its variable sensitivity with different gases, thus necessitating independent calibrations, and its power to act as a pump. Nevertheless, the speed of pumping for any particular gas can be determined, and, if used for short intervals of time, no significant pressure changes occur.

Getters, such as certain barium compounds, have been used for some 30 years in the electronic industry for the manufacture of thermionic valves. Their use in the field of vacuum has been limited because protective layers are formed fairly rapidly on the metals. To overcome such a limitation pumps have been designed in which the getter is evaporated continuously. The pumping performance of getter ion-pumps compared with that of diffusion pumps was recently discussed by Holland[14]. It appears that a choice between the two types depends on the particular system being evacuated.

In ultra-high-vacuum work it is essential to use greaseless valves. Not only do such valves allow high pumping speeds, owing to their high conductance to gas flow, but they have the advantages of being robust and capable of high-temperature degassing. The Alpert valve is capable of being baked at 400°C and when closed has an effective conductance to nitrogen of only 10^{-11} litres per second. After considerable use the conductance rises to only 10^{-10} litres per second, presumably through slight oxidation of the metal surface during baking. Alpert obtained vacua as low as 10^{-10} mm Hg by using such an isolation valve. The diffusion characteristics of a ceramic rod were used by Becker and Hartman[15] for monitoring small quantities of gas into a vacuum system. Careful control of gas admission was effected by varying the height of the exposed rod by raising or lowering mercury.

To obtain pressures less than 10^{-8} mm Hg, ion pumping is therefore used, with an all-glass apparatus incorporating metal valves for gas manipulation and with provision for baking the whole apparatus in an oven at 400°C. Alpert and Buritz[16] showed that the ultimate attainable pressure was limited neither by the X-ray limit of a properly designed ion gauge nor to the vapour pressure of the tungsten filament of the gauge, which was kept at around 2000°K. The ultimate pressure was apparently governed by the diffusion of helium from the atmosphere through the glass walls of the apparatus.

THE APPLICATION OF HIGH-VACUUM TECHNIQUES

Impurities can have a marked influence on the course of many chemical reactions. Sulphur may act as a catalyst in the formation of nickel carbonyl, at the same time being better known for its poisoning properties. In a study of reaction mechanism carefully controlled conditions are essential. The exclusion of oxygen, water vapour and other gases, to concentrations less than 1 part in 10^8, is necessary. Not only do low-pressure methods allow reactions to be investigated with more certainty but also experimental techniques become available, resulting in improved accuracy and providing information otherwise unobtainable. Such techniques are therefore of extreme importance in an elucidation of the mechanism of gas–metal reactions, especially during the early stages.

The preparation of 'clean' metal surfaces

In studies of gas–metal reactions, investigators have often ignored an essential pre-requisite, namely the need to limit the number of parameters that may affect the reactions. Apart from failure to consider the nature of the metal surface, the number of variables involved has been such as to make difficult a complete understanding of the processes taking place.

The properties of metal surfaces are sensitive to the method of preparation. Such properties may arise from the presence of an oxide layer (inevitable with almost all metals exposed to atmospheric conditions and with many even at pressures less than 10^{-6} mm Hg), concentration of foreign atoms or structural defects. An electro-polished or abraded surface would add further complications. The preparation of 'clean,' defined metal surfaces is, therefore, of particular significance.

From kinetic theory the number of gas molecules at pressure P, and absolute temperature T, striking unit area of a plane surface in unit time is given by

$$N = \frac{P}{(2\pi m \boldsymbol{k} T)^{1/2}} \quad .. \quad .. \quad (1)$$

where m = mass of impinging molecule and $\boldsymbol{k}$ = Boltzmann's constant.

For a pressure of 10^{-5} mm of oxygen at 23°C the value of N is $5{\cdot}0 \times 10^{15}$ atoms cm^{-2} sec^{-1}. Since the number of atoms per sq. cm of metal surface is approximately 10^{15} it is seen that an adsorbed oxygen monolayer could be formed in less than 1 sec; however, this is an over-simplification. Let $\frac{dq}{dt}$ be the rate of oxygen adsorption on the solid in molecules per unit time, then if A is the apparent surface area the number of molecules at a pressure P striking the solid in unit time, from equation (1), is

$$\frac{A\,P}{(2\pi m \boldsymbol{k} T)^{1/2}}$$

The ratio of the rate of adsorption to the rate of impact is the sticking coefficient, σ. Therefore

$$\sigma = \frac{dq}{dt} \Big/ \frac{A\,P}{(2\pi m \boldsymbol{k} T)^{1/2}}$$

If q_0 molecules are required to form a monolayer then the fractional coverage, θ, when q molecules are adsorbed is q/q_0. Therefore

$$\frac{d\theta}{dt} = \frac{1}{q_0}\,\frac{dq}{dt} = \frac{\sigma A P}{q_0 (2\pi m \boldsymbol{k} T)^{1/2}} \quad .. \quad (2)$$

Since the value of σ is less than unity and q_0 can be much greater than the value corresponding to 10^{15} molecules/cm^2 (*e.g.* with evaporated metal films), then the time of 1 sec to form a monolayer is a minimum one. It is, however, clear that in 'clean' surface preparation the best attainable vacuum conditions are essential to ensure freedom from appreciable contamination.

In general there are two methods for clean surface preparation, either 'cleaning' an initially contaminated one or generating a fresh one *in situ*. The first method consists of reduction, ion bombardment, and high-temperature flashing of filaments, and the second evaporation and single-crystal crushing techniques. It was J. K. Roberts[17] who demonstrated that the concept of 'clean' metal surfaces was a real one, in that carefully flashed tungsten filaments showed unique adsorption characteristics. Such surfaces were less than 1 cm^2 in area. The evaporated film technique[18] for metal preparation resulted in surfaces being prepared a thousand times larger in area, and it was to Roberts's credit that similar data to his were obtained. Evaporated metal films, however, may suffer from certain disadvantages, being unstable and capable of releasing stored energy[19 20 21]. A recent study[22] of evaporated iron films, using the physical adsorption of krypton as a criterion of surface area, has shown that the surface is apparently unstable both in vacuo ($<10^{-6}$ mm Hg) and in the presence of chemisorbed oxygen.

Reduction of metal powders has not, in general, been regarded as one of the better methods for 'clean' surface preparation. However, nickel oxide after reducing for up to 100 hours at 450°C, in very pure hydrogen, exhibits properties almost identical with those of evaporated nickel films[23]. On this basis alone the powder surface was considered to be 88 per cent 'clean.' The use of mercury cut-offs in reduction methods is of particular importance, otherwise good vacuum conditions are unobtainable because of occlusion of gas from stopcock grease. The apparatus should, where possible, be wrapped in heating tapes to ensure thorough degassing after the hydrogen reduction at atmospheric pressure.

Eggleton and Tompkins[24] have shown that iron filaments are particularly resistant to cleaning by ion bombardment. The thermal accommodation coefficient of neon was the parameter used in following surface characteristics. Hydrogen reduction followed by flashing *in vacuo* at 1200°C proved ineffective but neon-ion bombardment was successful if this was preceded by a preliminary bombardment with nitrogen ions. This preliminary nitrogen treatment is thought to form a barrier to any diffusion of impurities from the bulk metal to the surface. The bombardment of nickel surfaces with argon ions, in conjunction with high-temperature degassing in good vacuum, has led Farnsworth[25] to conclude that 'clean' surfaces are produced.

However, the problem of preparing definite, unequivocal 'clean' metal surfaces is one which cannot readily be solved. Different metals necessitate different techniques, some are easier to prepare, and others once prepared become contaminated very quickly. There is no doubt, however, that in any quantitative study of chemisorption or the preliminary stages of any gas–metal interaction the most stringent vacuum conditions are an essential prerequisite.

Adsorption by metal surfaces

The low-pressure adsorption of gases and vapours on surfaces can be divided into two categories, namely, physisorption and chemisorption. A distinct boundary between the two types is not possible but the former is generally regarded as being unspecific, having energies of adsorption of less than 5 kcal $mole^{-1}$, reversible in character and as occurring at temperatures near the boiling point of the gas. Chemisorption, on the other hand, is specific; the energy of adsorption is usually greater than 10 kcal $mole^{-1}$ and may be as high as 100 kcal $mole^{-1}$; it is mainly irreversible in nature. Both have provided very valuable information necessary to an understanding of the chemistry of surfaces.

Although for evaluation of surface area the B.E.T. theory[26] has usually been applied to nitrogen and argon

adsorption isotherms, these gases have the disadvantage of comparatively large vapour pressures at liquid oxygen and nitrogen temperatures. This means that surface areas less than a few $m^2\ gm^{-1}$ cannot be determined with any accuracy. The use of such gases as krypton, ethylene and butane in the pressure range 10^{-1} to 10^{-4} mm Hg at temperatures of −195°, −83° or −116°C, respectively, enable surface areas of a few 100 cm^2 to be determined. Areas as small as 50 cm^2 have been determined by Rosenberg[27] with a thermistor for following krypton pressure changes. The absolute accuracy of this technique may not be better than 30 per cent but relatively it is better than 5 per cent.

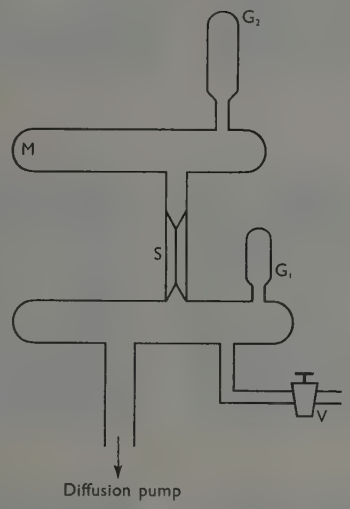


FIG. 2

Chemisorption, being a specific process, is therefore very sensitive to traces of impurities. A study of chemisorption is inseparable from high or ultra-high vacuum techniques and the preparation of 'clean' surfaces. Little would be known of the properties of chemisorbed layers without the now conventional high-vacuum techniques. The reversibility or otherwise of the adsorbed species, the heat of adsorption and its variation with surface coverage, the effect of impurities and the role of surface structure are all aspects which necessitate careful experimentation.

The conventional high-vacuum apparatus (ultimate pressure around 10^{-6} mm Hg) utilizing McLeod and Pirani gauges for pressure measurement suffer the disadvantage that a study of a very fast adsorption process is not feasible. This therefore means that almost all the initial chemisorption on metals can only be described by a phrase such as 'immeasurably fast.' Such a description would apply to the interaction of oxygen with almost any metal, and hydrogen and carbon monoxide with the transition metals. To permit a detailed investigation of such processes, measurements must be undertaken at very low gas pressures, for then the time needed for measurement is small compared with that for forming an adsorbed monolayer on the substrate. This means that the pressure must be 10^{-6} mm or less. In an investigation of fast chemisorption processes Wagener[28] and Bloomer[29] used a flow method. Basically the method is to use two ionization gauges, G_1 and G_2, connected by a capillary S of conductance C; G_1 is also connected to a high-vacuum diffusion pump by a short wide tube, and G_2 has a side arm in which the metal M to be investigated is located. The gas to be studied is injected via a bakable valve, V, into gauge G_1 where a certain pressure P_1 is produced. From here the gas flows through the capillary into the sorbent chamber, establishing a pressure P_2 as measured by ion gauge G_2. The apparatus is shown diagrammatically in Fig. 2.

The rate of adsorption, R, is given below.

$$R = \frac{C(P_1 - P_2)}{P_2} \qquad (3)$$

The sensitivity of the technique for carbon monoxide is $1{\cdot}5 \times 10^{-5}$ μg. This arises from the fact that a rate of adsorption of 10 cm^3/sec can be measured within 10 seconds at a pressure of 10^{-7} mm Hg. The initial pressure in the apparatus must be around 10^{-9} mm Hg. The influence of the pumping action of the ion gauge and sorption by the glass must be taken into account, as well as the gas purity. If the impurity is adsorbed at a much slower rate than the main gas it will establish a smaller pressure gradient across the capillary and therefore its partial pressure will be proportionately much higher on the sample side of the capillary than it is on the pump side.

In contrast to the above low-pressure flow technique the flash filament method is one which necessitates an ultra-high-vacuum static system. The metal surface is in the form of a filament, and one of the disadvantages of the technique for general applicability is that the metal must be capable of being heated to a high temperature without any evaporation. The principle of the method is that at any time, t, the number of molecules adsorbed can be determined by flashing the filament to around 2000°K and the sudden pressure rise measured.

Becker and Hartman[15] and Ehrlich and Hickmott[30] have studied the interaction of gases with tungsten filament surfaces in this way. The latter authors, in particular, have explored the reliability of results which had been obtained with high-vacuum systems, *i.e.* apparatus where pressures no better than 10^{-6} mm Hg could be obtained. They conclude that tungsten films evaporated at pressures of 10^{-6} mm Hg do not present

surfaces having the same degree of 'cleanliness' as can be achieved with filaments or films prepared by ultra-high-vacuum techniques and that the interpretation of experiments carried out under the former conditions is questionable. Moreover, even if the deposition of the film is carried out under the more rigorous conditions the absence of a noticeable pressure rise does not necessarily ensure a 'clean' surface, since the adsorption and evolution of gas may just balance.

Three states, designated α, β and γ, are now known for nitrogen adsorbed on a tungsten surface; such states were discovered by means of the flash filament technique. The α state is significantly populated at room temperature but the γ can only be detected below 200°K. In the latter case the binding is attributed to dispersion forces, whereas in the β state, where complete desorption does not occur until a temperature above 2000°K is reached, and in the α state chemisorption occurs.

When a gas is adsorbed by a surface its rate of adsorption is given by eqn (2). The sticking probability (the ratio of the observed rate of adsorption to the calculated one, assuming that every collision with the surface results in adsorption) and activation energy during the formation of the first layer have been determined for various gas–metal systems by the above two techniques. Some results are shown in Table I.

TABLE I

Metal	Gas	Sticking probability	Activation energy kcal mole^{-1}	Reference
Ba	CO	0·4	0·1	28
Ba	O_2	0·02	0·09	28
Ba	N_2	0·001	4	28
W	N_2	0·55	0·1	15
Ba	CO	0·01	—	29
Ba	O_2	0·04	—	31
W	N_2	0·12–0·26	—	30

Field emission microscopy

The field emission microscope was invented by E. W. Müller[32] in 1937 but it has only been used extensively during the last decade. The metal whose surface is being investigated is etched to a very sharp point and is surrounded by a fluorescent screen which acts as the anode. The system is outgassed to pressures of the order of 10^{-9} mm Hg and the wire heated to around 2000°K, which both degasses the metal and produces a smoothly rounded tip, the radius of which is of the order of 10^{-5} cm. If a potential of the order of 10^4 volts is applied between the metal tip and the fluorescent screen, electron emission occurs which provides a 'map' of the tip magnified by approximately a million times on the screen.

The electron emission, J (electrons per unit surface per unit time) is related to the work function of the surface, ϕ, by the Fowler–Nordheim[33] equation:

$$J = 6{\cdot}2 \times 10^6 (\mu/\phi)^{1/2} (\mu+\phi)^{-1} F^2 \exp\left(\frac{0{\cdot}84 \times 10^7 \phi^{3/2}}{F}\right) \quad . . (4)$$

where F is the applied field in V cm^{-1} and μ is the chemical potential of the electrons in the metal in eV, *i.e.* the energy of the highest filled level measured from the potential minimum in the metal.

Since the metal tip is made up of various crystallographic planes (*see* Fig. 3) which have different work

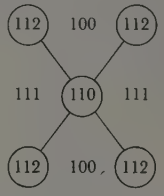


FIG. 3

functions, the planes can be distinguished by the relative brightness of patterns produced on the fluorescent screen. Differences in work function occur also as a result of adsorbed gases. Since the work function, ϕ, appears to the power 3/2 in the exponent of equation (4), changes in ϕ of the order of 0·01 eV produce marked changes in emission.

Thus, when a gas is adsorbed on the surface of the metal point it is possible to ascertain whether the molecules are preferentially adsorbed on certain planes, the directions in which they migrate and the temperature at which migration and desorption occur at observable rates.

For the attainment of the necessary ultra-high-vacuum conditions Gomer[34] has recently used liquid helium; this is a relatively simple and also a less time-consuming technique than that of 'pumping and baking.' To prevent the diffusion of helium through the glass walls of the tube they are first cooled to liquid nitrogen temperature before immersion in liquid helium.

Plate I shows a sequence of emission patterns obtained by Jacobs and Hill[35]; a tungsten tip, cleaned initially by heating to 2000°K at a pressure of less than 10^{-9} mm Hg, adsorbs oxygen at room temperature and a pressure of 5×10^{-8} mm Hg (Plate I, i–iv). The tip is then heated to 470°C and then to 1160°C for periods of 2 minutes (v and vi respectively). In order to follow the adsorption process in terms of the crystallographic planes in the tungsten surface, Fig. 3 represents diagrammatically the approximate position of the planes, *i.e.* in relation to the emission patterns in Plate I. A dark region corresponds to less electron emission than from other parts of the surface, and therefore a plane which becomes progressively darker during a particular sequence corresponds to an increase in the planar work function, usually as a result of adsorption.

The following outline describes the sequence of patterns shown in Plate I.

Pattern i: 15 seconds after preparing 'clean' tungsten tip. Slight adsorption of oxygen already visible around the 112 planes.

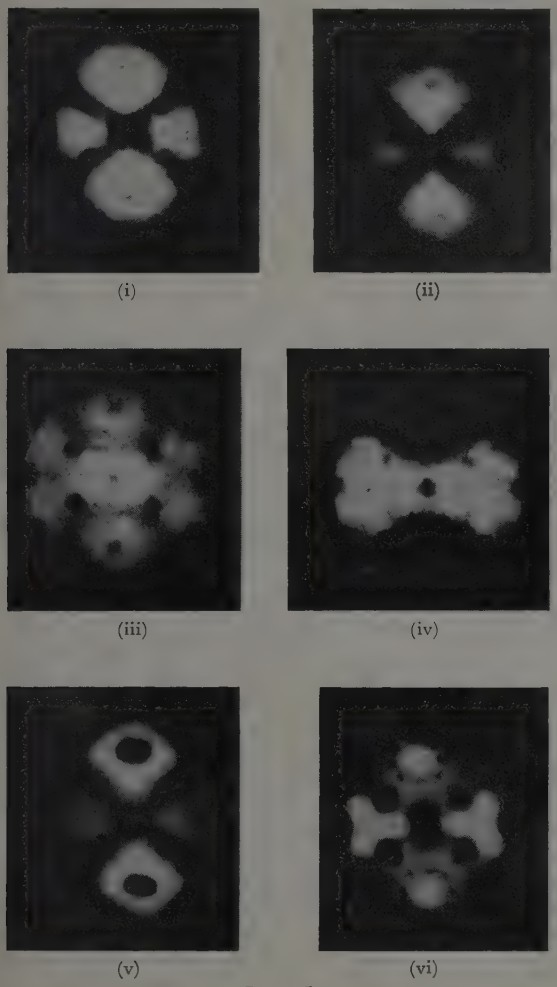


PLATE I

Pattern ii: 20 seconds after preparing tungsten tip. Heavy adsorption around 112 and 110 planes.

Pattern iii: 5 minutes after preparing tungsten tip. The field was increased approximately 50 per cent, showing higher emission of electrons around 110 plane than in pattern ii.

Pattern iv: 25 minutes after preparing 'clean' tungsten tip. Approaching oxygen 'saturation.'

Pattern v: Tungsten heated to 470°C for 2 minutes. Desorption of oxygen from around 100 planes.

Pattern vi: Tungsten tip heated for 2 minutes at 1160°C. Bright patches appear which are associated with oxide formation and tungsten migration, the latter resulting in 'steps' being produced in the tungsten surface.

Miscellaneous Applications

In the study of gas–solid reactions, techniques that depend on the measurement of pressure changes at constant volume have the disadvantage that they do not permit the easy separation of the two parameters, 'decrease in gas pressure' and 'increase in thickness of product on the surface'. This particular difficulty was overcome in the study of the interaction of nitrogen with calcium by the use of a constant low-pressure technique[36], a Pirani gauge being the null-point instrument. Not only did the method allow a separation of the above two variables but also the sensitivity was such that rates of nitridation corresponding to as little as 1/1000th of a monolayer per minute could be investigated. The activation energy for the nitridation process was found to increase linearly with the reciprocal of the nitride thickness. This suggested that the Mott–Cabrera theory[37] of thin-film formation was applicable and that Ca^{2+} ions were diffusing across the metal–nitride interface under the influence of a field.

Gregg[38], Gulbransen[39], Rhodin[40] and Stone[41] have used microbalances for gas–metal kinetic studies. Such balances, normally constructed of silica, are incorporated in a high-vacuum system, the sensitivity of the balance is approximately 10^{-6} g for a load of 1 g. In terms of the number of layers, this corresponds to one layer of oxygen adsorbed on a surface having an area of 14 cm^2. Gettering materials such as zirconium filaments or barium films is practicable provided the sample is protected by a system of baffles. In studies involving very high temperature degassing, double-walled reaction vessels are advisable to prevent contamination by diffusion of air. Certain ceramics such as mullite are an advantage, since they can be sealed directly to pyrex glass and also withstand temperatures up to 1000°C.

Fundamental studies in the field of catalysis have involved the use of carefully prepared metal surfaces. Kemball[42] has extensively studied the role of such surfaces in the hydrogen–deuterium exchange reaction and hydrocarbon decompositions, by mass spectrometric and high-vacuum techniques. A further development in this field may be that the omegatron, which will function under ultra-high-vacuum conditions, will supersede the mass spectrometer.

Much use is made of vacuum techniques in the preparation of radioisotopes. Considerations arising from the radioactive properties of such materials, and their consequent health hazards, add further to the

difficulties. The vacuum apparatus is normally housed in a 'dry box' with adequate ducting of radioactive waste and manipulation is effected by remote control. The three main types of radiations emitted are α, β and γ. The α-rays are of low energy and will not penetrate glass, the weaker β-rays will be adsorbed by glass a millimeter or so thick and the more energetic ones by aluminium foil a few millimeters in thickness. Adequate protection from γ-rays can only be effected by lead shielding of the appropriate thickness. Thus, only the latter radiation is likely to cause any great difficulty, but since the number of γ disintegrations may be less than 1 per cent of the β, the γ-ray intensity would be insignificant in some radiochemical investigations. This is so with ^{85}Kr, which emits both β- and γ-rays, though the latter occur with only 0·6 per cent of the β disintegrations. An important aspect of vacuum manipulation in radiochemical work is contamination of the glass apparatus and the absorption of active gas by stop-cock grease. The application of vacuum methods to the recovery of tritium, and the preparation and purification of ^{85}Kr and ^{133}Xe, has been described in detail.[43]

The dessication of heat-sensitive biological materials is of considerable medical importance and is effected by a process termed 'freeze-drying'. Such substances as blood plasma, vaccines and living micro-organisms are dried by evacuation at low temperatures. The vacuum pumping system for freeze-drying should provide for a very fast rate of pumping from atmospheric pressure to an ultimate pressure of 10^{-2} mm Hg and be capable of removing large quantities of water and permanent gas. The use of vacuum techniques in medicine was recently reviewed by Bounden and Rotblat[44].

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British Pharmaceutical Conference.—The British Pharmaceutical Conference will be held at Newcastle upon Tyne on 5-9 September. The Chairman's address, by Professor W. H. Linnell, will be entitled 'Academic Research and the Five Freedoms.' The subject of the Symposium Session on 8 September is Chemical Disinfection, and the discussion will be opened by Drs A. M. Cook, J. G. Davis and S. E. Jacobs and Mr A. H. Walters. Dr K. R. Capper will open the discussion at the Professional Session on 6 September on Change to the Metric System in Pharmaceutical Practice. Social events include a Civic Reception and Dance on the opening day, the Conference Banquet in the Empress Ballroom, Whitley Bay, on 6 September, and the Conference Ball in the Oxford Galleries on 9 September. Application forms, together with further information, should be obtained *as soon as possible* from the Honorary General Secretaries, British Pharmaceutical Conference, 17 Bloomsbury Square, London, W.C.1.

SOME ASPECTS OF THE STRUCTURAL CHEMISTRY OF PLATINUM

By E. G. Cox, T.D., D.SC., F.INST.P., F.R.I.C., F.R.S.*

Professor of Inorganic and Structural Chemistry, University of Leeds

My interest in co-ordination compounds was first seriously aroused by G. T. Morgan's display at the Wembley exhibition. By a coincidence the first substance on which I made measurements by means of X-rays was aluminium acetylacetone, one of Morgan's compounds, which was given me as an exercise by W. T. Astbury, to whom I apprenticed myself when I first went to the Royal Institution. My first original work on platinum compounds, however, was done in the University of Birmingham in collaboration with the late William Wardlaw, to whom I owe a great debt of gratitude for many reasons, and not least for introducing me to the serious study of co-ordination compounds, which has continued to give me pleasure ever since.

Stereochemistry as we now know it started about a hundred years ago in connection with the study of organic compounds. I do not recall any discussion about the spatial arangement of atoms in molecules published before 1850, although cases of isomerism were known at that time. For example, two isomeric diammino-platinous chlorides were recognized in 1845 and were formulated as $Cl.NH_3.Pt.NH_3.Cl$ and $Cl.Pt.NH_3.NH_3.Cl$ (Blomstrand and Cleve). Whereas a chemist today writing such formulae would almost automatically form a mental picture of the arrangement of the atoms, the investigators of 1845, knowing nothing of the sizes of atoms or of molecular structure, could apparently perform the, to us very difficult, feat of recognizing structural isomers without any stereochemical facts or principles to guide them. Not surprisingly, no great progress was made in inorganic stereochemistry before the time of Werner, whose investigations of co-ordination compounds, summed up in his *Neuere Anschauungen auf dem Gebiete der Anorganischen Chemie*, 1905, led not only to the idea of co-ordination of groups by apparently saturated metal atoms, but also laid the foundations of inorganic stereochemistry.

Werner came to the conclusion that the above-mentioned compounds, and a number of other pairs of platinum compounds, had planar configurations and were *cis* and *trans* isomers. The planar configuration for platinum and certain other metals is so much taken for granted today that it is difficult now to appreciate not only the magnitude of the step forward taken by Werner in advancing this hypothesis, but also on the one hand the slenderness of the evidence and on the other the intensity of the opposition to the idea. By the beginning of this century the idea of the tetrahedral distribution of four carbon valencies was so firmly established that any other distribution somehow seemed to be unnatural, and it had to be admitted that there was very little evidence, for example, that Werner's alleged stereoisomers were both monomeric.

Nevertheless the weight of the evidence was in favour of the planar configuration not only for four-covalent platinum compounds but also for the analogous compounds of palladium. There was on record one case of an apparently isomeric pair of nickel compounds (the monomethylglyoxime derivatives; Tschugaev, 1911) but Werner did not consider nickel to be analogous with platinum and palladium. On the other hand he was of the opinion that four-covalent zinc and cupric compounds were planar. Apart from the four-covalent compounds, many six-covalent compounds of platinum (and other metals) were known and it was accepted that these had octahedral configurations.

In 1922, Dickinson showed by X-ray analysis that the anions in K_2PtCl_4 and K_2PdCl_4 were square, in contrast to, for example, that in $K_2Zn(CN)_4$ which was tetrahedral. Nevertheless the case for planar four-covalent platinum and palladium could not be said to be firmly established as a generalization until the early 1930s. It was shown in the 1920s and early 1930s that many of the supposed *cis* and *trans* planar palladodiammines were not isomers, one of each pair being in fact a dimer. Reihlen claimed to have shown that the so-called *trans* $Pt(NH_3)_2Cl_2$ was dimeric (in liquid ammonia!) and also to have resolved the bis-isobutylene-diammine complex $Pt(H_2M.C(CH_3)_2CH_2NH_2)_2^{2+}$. Moreover Mann and Pope had prepared compounds of the kind $Pt\,tren\,I_2$ (tren = triaminotriethylamine) which, as can be seen from a model, could scarcely be planar. (The use of models, which is today commonplace, was by no means routine in those days: if it had been, such a manifestly absurd claim as the isolation of *cis* and *trans* diammino-platinous oxalate would never have been published.)

In the meantime wave mechanics had been introduced and it is this, with such developments as the Heitler–London interpretation of the Lewis shared-electron concept, Lennard-Jones's idea of molecular orbitals, and Pauling's concept of hybridization and the associated magnetic criterion for bond-type, that has been responsible for the great advances in theoretical inorganic stereochemistry in the last 30 years. At the same time new experimental techniques, and

* Lecture given to the Leeds Area Section, 15 February, 1960. For Dr Cox's new appointment *see* p. 293.

improvements in older ones, have made it possible to test the theory critically and to indicate where it needs modification or can profitably be developed. So far as the stereochemistry of platinum is concerned, we may date the new era from 1931 when Pauling showed that the principle of maximum overlap, deduced intuitively rather than formally from wave mechanics, led to predictions about the directions to be expected for hybridized bonds and at the same time to predictions about the changes in magnetic properties associated with bond-formation. He was able to predict specifically the planar diamagnetic configuration for four-covalent nickel compounds such as nickel bis-dimethylglyoxime, and although the magnetic criterion was not applicable to platinum and palladium, planar configurations were indicated for them also. X-ray studies, started at about the same time, confirmed beyond doubt that four-covalent platinous complexes, whether cationic or anionic, were normally planar. On the other hand theory and experiment showed that the stereochemistry of a metal depended on its state of oxidation, and specifically it seemed likely that platinic compounds might not be planar.

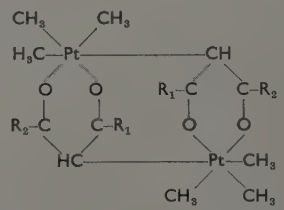
Although the planar and octahedral configurations for most platinous compounds are no longer in dispute, platinum continues to present interesting stereochemical problems, and unexpected results continue to be obtained. The following examples are taken from post-war investigations, because until comparatively recently X-ray analysis was not developed sufficiently to enable us to determine the positions of light atoms in the presence of platinum,and this is essential for the solution of all but the simplest stereochemical problems.

Many interesting compounds can be derived from trimethylplatinic iodide, which was first made by Pope and Peachey about 55 years ago. This substance and all its derivatives have a great propensity towards the formation of polynuclear complexes. The parent substance itself has not been examined in detail but the chloride has a tetrameric structure in which four platinum atoms and four chlorine atoms are arranged alternately at the corners of a cube (the edges of which represent electron-deficient bonds), each platinum having thus (with three methyl groups) an octahedral configuration. $Pt(CH_3)_4$ is thought to have the same structure (the basis of which is very much the same geometrically as that proposed for the thallium alkoxides by Sidgwick & Sutton in 1930).

R. C. Menzies (who first studied the thallium alkoxides) prepared $Pt(Ch_3)_3I$. $1\frac{1}{2}$en (en = ethylenediamine). This must be at least binuclear, but many isomers are possible and it was of interest to determine its structure. Dr M. R. Truter's X-ray work showed it to be binuclear with a single ethylenediamine bridge between the octahedral platinum atoms; as in all such compounds studied so far the three methyl groups are *cis*. The results are intrinsically interesting but perhaps the main value of the work was in establishing that carbon and other light atoms could be located reasonably accurately notwithstanding the presence of the heavy platinum and iodine atoms.

The ethylenediamine compound is a salt; Menzies also prepared (1928) a molecular complex $(CH_3)_3Pt$ acac (acac = $CH_3CO{\cdot}CH{\cdot}CO{\cdot}CH_3$) which proved to be of considerable interest as the first volatile compound of platinum. It is of interest stereochemically because if it were monomeric it would be the first example of five-covalent platinum, and, although molecular weight determinations in solution suggested that it was dimeric, it was still of considerable interest to discover the nature of the bridging in the dimer; methyl bridges seemed most likely, but another possibility was sharing of oxygen atoms (*cf.* the Sidgwick–Sutton proposals for thallium alkoxides). Bridging by means of the bidentate acetylacetone residue would not appear to offer a means of raising the co-ordination number of the platinum to six.

The simple acetylacetone compound was unsuitable for detailed analysis, and Dr Menzies kindly made for us some substituted compounds, which Dr Truter, with Mr Swallow and Mr Hazell, subjected to X-ray analysis. One of these was $(CH_3)_3Pt\ CH_3{\cdot}CO{\cdot}CH{\cdot}CO{\cdot}OC_2H_5$ so that in this case a third oxygen atom was available for possible co-ordination to platinum; the other was $(CH_3)_3Pt\ C_3H_7{\cdot}CO{\cdot}CH{\cdot}CO{\cdot}C_3H_7$. Both molecules were found to be binuclear, centro-symmetrical, with approximately octahedral platinum valencies. The extra bond is formed with the central ('acidic') carbon atom of the complex as shown, but we do not yet know whether the Pt–C bonding in this interesting new type of coordination involves a π-orbital of a trigonally hybridized carbon or an sp^3 orbital of a tetrahedral carbon atom.



So far no monomeric platinic complex has been discovered, and in those complexes which have been studied the platinum atoms have been found to have octahedral configurations. One of the interesting questions for the future is therefore the stereochemistry of four-covalent platinic complexes—if they exist. It will also be of interest to continue the search for complexes, both platinic and platinous, in which the co-ordination number of the metal atom is neither 4 nor 6, but perhaps 3 or 5 or even 7 or 8; and, since the existence of PtF_6 has been established, the search for the unexpected might well be extended to complexes containing platinum in oxidation states other than II and IV.

Book Reviews

A HISTORY OF METALS. L. Aitchison. VOLUME I. Pp. xxi + 304. VOLUME II. Pp. xvii + 305-647. *London: Macdonald & Evans Ltd*, 1960. 168*s*.

Professor Aitchison has excellent qualifications for writing a history of metals, and has made good use of them. His book is intended for the professional metallurgist and the general reader. It gives a good historical and archaeological background. The author, who claims to 'avoid technical jargon,' says that it would be neither sensible nor possible to give detailed references, and that he has 'woven with thread deriving from several different authors.' His references, which are collected at the ends of the chapters, are few in number, and do not always give page references. The book is printed on glossy heavy paper and is profusely illustrated; many of the illustrations have artistic interest only. Not more than half of the total number of pages can be devoted to text. The specialist in the history of science needs something different—a smaller book with fewer pictures and every statement accompanied by its source (something like the 130 pages at the end of Lippmann's first volume on the history of alchemy, corrected and brought up to date). The specialist looks for a reassessment of difficult problems in the light of present knowledge in a way which the general reader would regard as pedantic. It would obviously be quite unfair and misleading to judge the present book from such a point of view.

The first volume deals with the ancient period in Egypt, Mesopotamia, Asia Minor, Troy and Crete. It is based on modern sources, and the analyses of metals given in tables are a good feature. China and the Indus Valley civilization are dealt with briefly but satisfactorily, and early European metallurgy is then considered. The text passes from one region to another in a way which some may find confusing, but it is part of the author's plan. The metallurgical details are admirable, but the author has been misled by some recent laboratory experiments on the production of iron. The reproduction of ancient techniques is not easy, and it is only in fairly recent times that the exact conditions for the production of Egyptian blue and of black-topped pottery, for example, have been discovered.

The sections on India and China are brief, and the very efficient Chinese bellows which helped the production of cast iron do not seem to be mentioned. All the ancient metals are dealt with, and the volume closes with a chapter on alchemy. This first volume should be most useful to archaeologists.

The second volume begins at the Middle Ages and continues to the most modern times; it closes with neptunium and plutonium. Two sources often quoted, Bartholomeus Anglicus and Pettus, are the author's favourites but are disesteemed by specialists, and surely Bartholomeus's Greek name for gold should be *chrusos* and not *chrufos*. Agricola naturally comes into the picture in some detail but the question as to how much he really knew of the things he describes is not discussed. The author is unfair to Yarranton, who was 'inquisitive' and 'garrulous,' and a mere linen draper. He seems to have brought some good information but was swindled by persons in high places. It is impossible to give even an outline of the contents of this volume but it may be said that the rise and progress of all the modern metallurgical techniques are set out with sufficient detail and in a very interesting way. All this will be of great interest to the technologist, and, if he is willing to rely on the author without detailed references, to the historian of science.

It would be ungenerous to note all the faults encountered in the book, but it may be mentioned that 'Duhamel and du Monceau' were one person, not two, that Kazvini should be Qazwini, that the Bactrian specimen of cupro-nickel is not mentioned, that Humboldt and not Del Rio is given as having recognized vanadium, that Stahl did not propose the phlogiston theory in 1702, and that potassium bicarbonate cannot be fused. Such slips, and there are others, make the book less suitable for reference than it might have been.

Professor Aitchison's book is one that the readers for whom it is intended will enjoy as much as he seems to have enjoyed writing it. It is very well written, contains a great store of information not easily found, if at all, in other books, and is an achievement on which he richly deserves congratulation. No library should be without it and those individuals who can afford it will be well advised to buy it. In its field it will surely rank as authoritative for many years to come.

J. R. PARTINGTON

ZONE REFINING AND ALLIED TECHNIQUES. N. L. Parr. Pp. xvi + 184. *London: George Newnes Ltd*, 1960. 40*s*.

This work is a very welcome addition to the few books dealing with zone refining. The process is treated from the standpoint of the manipulation of metals but other applications are mentioned in appropriate places. The emphasis throughout is on the construction of mechanical equipment and, to aid in the assembly of apparatus, the text is illustrated with 122 excellent diagrams and with numerous photographs showing both simple and elaborate equipment. The pictures convey a great deal of information except for plate IV which shows merely two metal boxes fitted with a few instrument dials. The allied techniques discussed include single crystal growth, procedures for adjusting composition, heat treatment and metal working.

The two chapters dealing with theory are disappointing, and it is doubtful if a reader new to the subject would grasp easily many of the essential features of the process. For example, there is no clear statement of the

relationship between width of zone, length of bar and the ultimate impurity distribution attainable.

The chapters entitled 'Practical Considerations in Zone Refining', 'Choice and Design of Zone-Refining Equipment' and 'Examples of Zone-Refining Equipment' contain a wealth of information but by a judicious combination of material they could have been made into one chapter and thus much repetition could have been avoided. Some interesting suggestions are made for conducting continuous zone-refining experiments, although no commercial equipment for carrying out a continuous process is known. Extant equipment for treating milligram quantities of organic materials is not mentioned.

Among the processes discussed for the manipulation of pure materials are the production of bars by the pressing and sintering of metal powders, vacuum and controlled atmosphere melting, casting and welding, levitation melting, solid-state recrystallization, crystal slicing and crystal cutting. The chemical and physical examination, and the properties and applications of high-purity substances are considered briefly.

The literature coverage is in the main excellent, although the work of certain French workers (*e.g.* Süe *et al.*, 1958) has been missed with the result that the sentence, 'Some success may, however, be expected with heavy water' (p. 175) was out of date two years before the book was published. Nevertheless, anybody who has occasion to zone-melt metals or who is required to produce semiconducting materials would find this book very useful.

E. F. G. HERINGTON

BENTLEY AND DRIVER'S TEXTBOOK OF PHARMACEUTICAL CHEMISTRY. Seventh Edition. J. E. Driver. Pp. ix + 728. *London: Oxford University Press*, 1960. 63*s*.

This new edition of a classic work is a great improvement on its predecessors. The treatment, especially of organic chemistry, is much more general, in keeping with the change in attitude of teachers of chemistry that has occurred in recent years.

As before, the book is divided into three parts: analytical methods, inorganic and organic. Part I has been greatly improved by the introduction of two new chapters, on organometallic complexes in analysis (including a useful section on the uses of EDTA), and on measurement of radioactivity, and the chapter on photometric methods has been improved by the addition of a section on ultra-violet absorption.

The first two chapters in Part II deal with atomic nuclei and radioactivity and with periodicity and valency. These are new and are well done, although the treatment is elementary. The remaining chapters in Part II differ little from the corresponding parts of the last edition, except for the deletion of certain chemicals such as Rochelle salt, mercuric chloride and calcium phosphate, which are no longer in the *British Pharmacopoeia*. As before, the preparation, properties and assays of inorganic medicinals are well done, and there appear to be no errors here, or, for that matter, in any other part of the book.

Part III has benefited from a more drastic revision. The first twenty-six chapters deal with the main chemical functional groups, medicinal compounds being used as examples of each type, providing such compounds receive recognition in the current Pharmacopoeia. One misses old friends such as 'Amylene Hydrate' but is pleased to welcome new ones, *e.g.* Mustine Hydrochloride. The former chapter on synthetic medicinal chemicals has been expanded to twelve chapters in the new edition, each dealing with a different chemical type, *e.g.* pyridine derivatives, iminazole derivatives and sulphonamides. Similarly proteins, hormones, vitamins and antibiotics now cover four chapters instead of one.

The faults in this work arise from the fact that it is now no longer possible to deal with pharmaceutical chemistry in one volume. Classical physical chemistry, the importance of which is increasing for students of pharmacy, is absent, insufficient space is devoted to methods (other than colorimetric) of measuring pH, and no space at all is devoted to chemicals used as tools in analysis or synthesis, such as thionyl chloride, potassium iodate and lead tetra-acetate. On the organic side proofs of structure (where given) still depend too much on synthesis, and little attention is given to degradative processes. Finally, now that all pharmaceutical students have to pursue a three-year course, some space should have been found for general chemotherapy and the factors controlling drug action, such as ionization, size and shape of molecules and theories of antimetabolites.

In spite of the above criticisms it is only fair to say that the new 'Bentley and Driver' is worthy to take its place on the shelves of any pharmaceutical student or industrial pharmaceutical chemist. It is beautifully printed on fine paper and the structural formulae are well drawn. With its attractive format and its wealth of information it is remarkably good value for money.

LOUIS K. SHARP

MECHANICAL DESIGN OF LABORATORY APPARATUS. H. J. J. Braddick. (The Institute of Physics, Monographs for Students.) Pp. 47. *London: Chapman & Hall Ltd*; *New York: Reinhold Publishing Corporation*, 1960. 6*s*.

This monograph is one of a series intended primarily for students in Higher National Certificate Courses in Applied Physics.

The main topic under consideration is the principles of design, and the author presents his subject in a systematic manner by surveying the basic factors that play a part in the design of laboratory apparatus. Thus the content of the main chapter is divided into sections

dealing with such matters as kinematic considerations, bearings, appreciation of kinematic design, the idea of sub-assemblies, rotational connexions, translational connexions and so forth. Full use is made of simple, easy-to-follow line diagrams.

The first and last chapters of this three-chapter monograph are short, covering four pages between them. In the last chapter the author deals with fabrication and the use of castings, and in the introductory one with the importance of mechanical design and the economics and merits of laboratory-constructed apparatus against that supplied commercially.

Since the aim of the monograph is 'to help young scientific workers in designing and assembling laboratory apparatus', it is a pity that more attention is not paid to complete assemblies of apparatus.

Even though the greater proportion of the chemist's requirements can be economically supplied by commercial firms, the monograph can help to develop good judgment as regards the quality of apparatus.

J. D. R. THOMAS

THE COLLECTED PAPERS OF PAUL EHRLICH. VOLUME III. CHEMOTHERAPY. Edited by F. Himmelweit. Pp. viii + 615. *Oxford: Pergamon Press Ltd*, 1960. 160*s*.

It is difficult to know whether one is consoled or depressed by the naïvety and ordinary ambitions of distinguished men. Paul Ehrlich, to whom humanity owes so much, was as much concerned with the acknowledgement of his priority at a time when his reputation was safely established as is the young scientist now who is certain that all his colleagues are endeavouring to steal his ideas. He strikes one as being naïve because he was never short of a hypothesis to explain the biological phenomena with which he was concerned. He was the type of scientist who would have disclosed in advance his 'Sunday morning' experiments. In a sense this was his strength. He was a pioneer; there were no established theories to be overcome and he had a firm faith in himself. The present collection of his papers on chemotherapy, compiled and edited by Dr Himmelweit with the assistance of the late Martha Marquardt, and introduced by Sir Henry Dale, is an enduring monument to his energy and originality.

This volume, in addition to the introduction, contains 17 articles dealing with early studies with dyes and arsenical compounds, the first of which, on the action of methylene blue on malaria, is dated 1891. Also included are the three Harben Lectures delivered in London in 1907 on experimental researches on specific therapy. Next come 22 papers on Salvarsan and Neosalvarsan and then 'Last Studies and Reviews,' which consists of seven papers, the final one having been published in 1915 in collaboration with P. Karrer. An addendum contains a number of obituary notices and personal tributes to colleagues written by Ehrlich.

The title of the book will give no indication to the unwary that only a small fraction of the published material is in English. Of the 60 separate items, 47 are in German, five, including the Harben Lectures, appeared originally in English, and in addition seven have been translated into English and one into French. Two papers are published here for the first time—a letter to Professor Darmstädter (1905) and an address at the dedication of the George Speyer House (1906).

This is a handsome, beautifully bound volume, produced with the co-operation and assistance of the Wellcome Trust. Its production must have been a very expensive undertaking. For this reason, the reviewer is willing to put himself in a vulnerable position by expressing the opinion that it would have been worth while to translate it completely into English. The fact that seven papers have been translated suggests that the publishers share this opinion. It is not an exaggeration to state that most of us who grew up and live in the English-speaking world find English easier to understand than German.

For an assessment of Ehrlich's uncomplicated genius and the permanent significance of his achievement in fathering the science of chemotherapy it would be difficult to improve on the graceful and mellow introduction of Sir Henry Dale, who is also responsible for the editorial direction.

V. C. BARRY

PHOTOCHEMISTRY IN THE LIQUID AND SOLID STATES. L. J. Heidt, R. S. Livingston and E. Rabinowitch. Pp. vi + 174. *New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd*, 1960. 40*s*.

One important potential application of photochemistry is the utilization and storage of solar energy. Already the 'solar battery' has achieved a high efficiency in converting solar radiation directly into electricity, but its cost and the need to store the electrical energy produced make it impractical as yet for under-developed regions of the world. Photochemical methods could be very useful, but they demand a process which occurs when visible and near infra-red light is absorbed. This must yield products that are stable at normal temperatures but can react to liberate a high proportion of the absorbed energy. The problem of finding a process which is as efficient as that occurring in plants is considerable, and this volume includes 24 papers on the subject presented at the conference held at Dedham, Mass., in September, 1957. In addition, there are an introduction and a summary by the editors, giving a very clear discussion of the problems involved in the photochemical storage of energy.

The papers cover a wide range of topics at a high standard, and range from direct consideration of energy storage problems such as kinetics, photosynthesis and the possible use of the nitrosyl chloride photolysis, to

papers on topics such as fluorescence, photosensitization, elementary photo-processes, solid-state photolysis and investigations of chlorophyll, the understanding of which is vital to the efficient use of solar energy. In addition, there are a few papers on specialized topics which do not seem to have any connection with the general scheme. These could well have been replaced by some record of the discussions, particularly as half the papers have already appeared in *J. phys. Chem.* for January, 1959.

With this minor reservation, the book can be recommended as background reading for those interested in problems of photochemical energy storage. It is easy to read, well laid out and comparatively free from errors, and it is to be hoped that librarians, who will probably be its main purchasers, will not be deterred by the format ($11\frac{1}{4}$ in. $\times$ $8\frac{1}{2}$ in.) which makes it too large to be stored easily with the standard works on photochemistry.

B. A. THRUSH

GRAPHITE AND ITS CRYSTAL COMPOUNDS. A. R. Ubbelohde and F. A. Lewis. Pp. xii + 217. *Clarendon Press: Oxford University Press*, 1960. 35*s*.

Those who have seen the papers of the Buffalo and London Carbon Conferences will not find anything new here. Professor Ubbelohde is a comparative newcomer to the graphite field, and it is therefore hardly surprising that this book has not quite 'come off.' It is a pity that the excellent literature survey is put together without much attempt at weaving it into a coherent whole. For example, in Chapter 1 various brief and very correct references to irradiation damage are strung out and unrelated to the main theme.

It is surprising to see B.E.T. nitrogen areas quoted as 0·47–0·87 m^2g^{-1} (p. 39) when a second place of decimals in such a low figure is obviously outside the B.E.T. range of accuracy. More space could have been given to the new adsorption techniques that have proved so useful for graphite. When discussing the size of accessible pores, particularly with respect to adsorption, it should be noted that such measurements depend on outgassing temperature, *i.e.* the higher the outgassing temperature, the greater the apparent area.

Chapters 2 and 3 seem unnecessary, as all this has been said so many times before. Chapter 4 is extremely good—here Professor Ubbelohde is obviously 'batting on his own ground' and has pieced together a complicated mass of data in an attractive fashion. Chapter 5, which has the book title for its heading, is rather vague, and I think a generous reference in the introductory paragraph to Rudorff, Croft and Hennig would have been appropriate, for this is their work. I find Croft's review (*Quart. Rev. chem. Soc.*, 1960, **14** (1), 1) much more readable and informative. Chapters 8 and 9 are extremely good theoretically, and here a definite attempt has been made to link together many useful data. Unfortunately, however, there is very little practical information on techniques, although this would be most useful to people interested in oxidation of graphite.

I should like to have this book on my bookshelf as it is a good source of references on graphite—the first of its kind in my working life.

E. R. BRAITHWAITE

ION EXCHANGE. A Laboratory Manual. J. E. Salmon and D. K. Hale. Pp. vii + 136. *London: Butterworths Scientific Publications; New York: Academic Press Inc.*, 1959. 25*s*.

Many books on ion exchange have been published in the past few years. When another volume on the subject appears, therefore, one automatically tends to look for a new approach.

This book is intended as a laboratory manual suitable for schools and colleges. It comprises 11 chapters. After an introduction, which neatly reviews the historical development of the subject and provides a basis for further study, the preparation of ion-exchange resins is considered. Successive chapters deal with the properties of ion-exchangers, the behaviour of columns and ion-exchange chromatography, techniques and apparatus, basic experiments with ion-exchangers, some experiments in simple column operation, simple procedures commonly employed in analysis, ion exchange in preparative chemistry and in purification and recovery processes, ion-exchange chromatography and ion exchange in the study of complexes. Broadly speaking, the book is divided into two parts, the first dealing with the theoretical aspects or principles of the subject and the second outlining laboratory experiments. One criticism which might be made is that several chapters dealing with the principles could have been shortened, in particular the one concerned with the preparation of ion-exchange resins, thus allowing more space for the description of laboratory experiments, of which some 23 are mentioned. They range from capacity determination of resins to preliminary studies in the sorption of complex ions. The number of experiments given in the two main types of applications, analysis and chromatography, is rather small, and the same criticism could also be applied to the experiments on ion exchangers in preparative chemistry. A useful inclusion, however, is the discussion of experiments at the end of each chapter.

The book is well written and free from typographical errors. The chapters dealing with principles are presented in a lucid way, and each contains a list of pertinent references. A bibliography of some of the more important works on ion exchange is given at the end of the book, which should become a valuable instruction manual in schools and perhaps first-year classes at universities.

R. J. MAGEE

BIOCHEMICAL PREPARATIONS. VOLUME VII. Editor-in-Chief, H. A. Lardy. Pp. ix + 102. *New York: John Wiley & Sons Inc.; London: Chapman & Hall Ltd*, 1960. 42*s*.

The value of *Biochemical Preparations* as an experimental handbook for biochemists is now thoroughly established. Many of the volumes, however, and this one in particular, are specially useful to those unfortunate beings who 'have not got the biological sense' but who, nevertheless, like to know when some obscure organic compound emerges as a co-enzyme, or as a substrate for a new enzyme, as an intermediate stage in some cycle or as an ingredient of living tissue. A pleasing feature of this volume is that, where necessary, the contributors usually indicate the biological significance of the compound under consideration by excellent addenda and footnotes, thus raising the scientific value of the book far above that of a mere list of recipes.

Several compounds now acquiring biochemical importance are listed. Hydroxypyruvic acid phosphate is concerned in an enzymic transamination giving serine phosphate. The preparation of flavin adenine dinucleotide from the mycelium of *Eremothecium ashbyii* is complicated but superior to earlier methods involving kidney, liver or yeast. It is not stated how the mycelium of this mould was found to be so rich in flavins; probably its yellow colour may have prompted someone to make a happy guess and a still happier experiment. We wonder whether moulds of the *Aspergillus flavus oryzae* type have been considered in this connection.

Methylmalonic semi-aldehyde is involved in the metabolism of valine. The preparation of carbamyl phosphate and its determination by the use of the enzyme, ornithine transcarbamylase, and ornithine in a buffered medium are particularly interesting. Citrulline and orthophosphate are produced. The recent work of Lipmann, Ratner and others with carbamyl phosphate extends the researches of Krebs in 1932 on the synthesis of urea in animals.

A method for the isolation of potassium dihydrogen isocitrate from various *Crassulaceae* is welcome. Isocitric acid is now firmly embedded in the Krebs cycle; about 35 years ago it was shown by Nelson to be the principal ingredient of the acids of the blackberry.

Details are also given for the preparation of tetrahydrofolic acid and of *S*-palmityl co-enzyme A, and many references are appended to the preparation of other fatty-acid derivatives of the co-enzyme.

FREDERICK CHALLENGER

PLANT AND ANIMAL BIOLOGY. First Edition. A. E. Vines and N. Rees. Volume I, pp. x + 1306, 60*s*.; Volume II, pp. viii + 806, 40*s*. *London: Sir Isaac Pitman & Sons Ltd*, 1960.

This is in every way a weighty publication and its size may well deter all but the most serious student. It should be explained, however, that the book is intended as a textbook for students of both botany and zoology up to 'A' level and scholarship level in the General Certificate of Education and thus in effect covers the requirements for two separate subjects. It can also be used by selecting appropriate material by students studying biology to 'A' or scholarship level and it also covers the needs of first-year university students in taking any of these three subjects. The value of studying botany and zoology from a textbook which treats them as aspects of one single discipline is immediately apparent from even a cursory perusal of the contents.

Volume I is composed of 36 chapters and is a systematic account of the morphology, anatomy and histology of the whole of the animal and vegetable kingdoms, with detailed descriptions of selected representatives of various classes of organisms. The authors have adequately fulfilled their avowed intention of stressing the fundamental links between environment, structure and function and the broad evolutionary trends within each kingdom. This volume contains over 1,000 line drawings and diagrams.

Volume II, with 23 chapters, describes the chemistry, biochemistry and physiology of plants and animals and the two volumes are intended to be used in conjunction with one another. Thus the opening chapters of the second volume, dealing with cell physiology and environmental conditions, have been designed to follow the introductory chapters of the first volume dealing with cell structure and behaviour. Students are then advised to work through the systematic and structural details of the organisms comprising the rest of volume I, and at the same time study the chemistry and physiology of the same organisms as described in volume II. This volume also contains numerous drawings, some duplicating those in volume I. Both volumes contain as appendixes a selection of questions from examination papers, arranged in the order in which the subjects are discussed in the book.

The style is terse and strictly factual, even didactic, allowing no scope for controversy. Indeed, many matters still regarded by specialists as controversial are recorded as accepted facts. There is no space, unfortunately, to indicate to the student how our knowledge of living organisms has been gradually built up over a period of years nor is there any suggestion that certain facts may have to be modified in the light of future research. Much of the material is over-simplified and much of importance has been dismissed in a sentence or two. This is understandable considering the vast areas of knowledge which the authors have attempted to cover in these two volumes. Indeed, in many instances the authors are to be congratulated on their success in packing a considerable amount of valuable information into a small space as illustrated, for example, by their descriptions of the complicated subjects of carbohydrate metabolism in animals and photosynthesis in plants.

The chemistry included in volume II is unfortunately rather sketchy and it is hoped that students will supplement the information given by consulting chemistry textbooks. The most serious criticism relates to the structural formulae, several of which are wrong, the errors ranging from the simple omission of a double bond to the quite misleading formula given for chlorophyll, which contains four separate mistakes. As far as I can tell from my limited knowledge of biology, the biological descriptions are reliable and accurate and the diagrams are clear and helpful, and it is most unfortunate that the general high level of the book is marred by a few mistakes in structural formulae.

In the Preface the authors state that they took five years in preparing the book, a statement which is easy to believe bearing in mind the wide range of the subject matter. Clearly, it must have been extremely difficult to ensure that everything in the book was up to date, and there are a few indications that all the facts were not checked immediately before publication as some out-of-date terminology, for instance in the nomenclature of the vitamins, has crept in.

These criticisms apply to a very small proportion of the book, which is otherwise warmly to be commended to the student for whom it is intended. It covers a vast amount of knowledge and indeed one hopes that students will only be expected to master a few of the facts contained in the book in preparing for examinations and that teachers and tutors will supplement these bare bones with some account of the human aspects of scientific research by telling their students something of the way in which research is conducted, and of the way that hypotheses are tested by further experiments and confirmed or modified in the light of the results.

The book is well printed and remarkably free from errors except those in the formulae to which reference has already been made. It is very well bound with a strong and attractively printed dust cover.

F. A. ROBINSON

THE BACTERIA: A TREATISE ON STRUCTURE AND FUNCTION. VOLUME I, STRUCTURE. Edited by I. C. Gunsalus and R. Y. Stanier. Pp. xiv + 513. *New York: Academic Press, Inc.; London: Academic Books Ltd*, 1960. $13.00, 104*s*.

The appearance of the first volume of this new treatise will be welcomed by biochemists and microbiologists as a step towards the filling of a gap in scientific literature. The purpose of the complete work will be to provide a 'comprehensive source of information about modern knowledge of the general biological properties of bacteria,' but chemists will realize from the titles of future volumes in the work—metabolism, biosynthesis, growth and heredity—that strong emphasis is placed on the chemistry of the structures and processes discussed. The editors are to be congratulated on their recognition of the need for a comprehensive book of this type and on their skill in selecting such a distinguished group of contributors.

The first volume is confined to the description of the physical structure of bacteria, as revealed for the most part by microscopy; but sub-microscopic structures in the cytoplasm are also considered in some detail. The treatment of the subject is general and chapters are devoted to each of the well-recognized visible cell structures. Generalization about structure in the bacteria is as difficult as it is with any other form of life, and one of the most interesting aspects of the chemistry of bacterial structure is that the differences in chemical composition of a given structure in different organisms can be most marked.

Our knowledge of the physical structures associated with bacteria has advanced rapidly during recent years, and electron microscopy has probably contributed more to this advance than has any other single technique. This is amply illustrated by the numerous high-quality photographs reproduced in this volume. The combination of electron microscopy, mechanical separation techniques and modern methods of chemical analysis has resulted in profound developments in our knowledge of the general nature of such structures as protoplasm, surface layers (capsules and walls), flagella, spores and protoplasts. The recognition that penicillin exerts its characteristic effect on bacteria by interfering with the formation of the wall is just one of a number of important discoveries which have arisen from new knowledge of bacterial structure.

The importance of L-forms is recognized by a chapter devoted entirely to this topic, and the fascinating developments in our understanding of bacteriophages and their mechanism of action are described in another chapter. Useful discussions are also included on the localization of enzymes and on the use of antigenic analysis in studies on the components of bacteria. The latter topic is described particularly for the reader who lacks experience in immunological techniques and training.

The chapters in this volume are authoritative and detailed as well as readable. Some overlap of subject matter is inevitable in a comprehensive treatise. The editors have succeeded in keeping this down to a minimum and yet maintaining clarity. Such a compromise is not easily attained in discussions on individual structures which are closely inter-related.

This book is strongly recommended to investigators in microbiology and biochemistry and should be particularly valuable to those chemists who wish to increase our knowledge of living structures and processes. The bacteria offer abundant material for their work. The diversity of the chemical processes which occur in bacteria has been appreciated by chemists for some time, and this volume will serve to emphasize that such diversity is not confined to metabolic processes. The appearance of subsequent volumes is awaited with enthusiasm.

J. BADDILEY

Institute Affairs

Royal Australian Chemical Institute.—Dr D. W. Kent-Jones, *Past President*, took the opportunity of meeting members of the council of the Royal Australian Chemical Institute in Melbourne during his recent visit, and was entertained to dinner by members of the council on 12 May. The purpose of Dr Kent-Jones's visit was to attend the opening of the new Bread Research Institute in Sydney. He had previously advised the Australian Government on the setting up of research facilities in this field.

Recognition of Colleges.—Enfield Technical College has been granted provisional recognition for the training of students to the Part I level of the Graduate Membership examination. The Liaison Officer for the College will be Mr L. C. Cosgrave, *Associate*, Senior Lecturer in chemistry in the Department of Pure and Applied Science.

Advisory Committee.—Mr N. Nix, *Associate*, has been nominated as an Institute representative on the Advisory Panel for the Chemical Industry of the Regional Advisory Council for the Organization of Further Education in the East Midlands, in succession to the late Mr S. W. Atherley. The second Institute representative on this Committee is Mr W. Keane, M.B.E., *Fellow*. A complete list of Institute representatives was published in July (*J.*, 252).

Local Section Boundaries.—On the recommendation of the Committee of the London Section, with the concurrence of the Committee of the East Anglia Section, the Council has approved the transfer, to the area of the London Section, of that part of the County of Essex lying between the border with Cambridgeshire and a line drawn from the juncture of the boundaries of Cambridgeshire, Suffolk and Essex near Haverhill, passing just west of Helion Bumpstead and just south of Great Sampford, Debden Green, Quendon and Clavering, meeting the Essex-Hertfordshire border due west of Clavering. This adjustment of boundary has been made to meet the wishes of members resident in or near Saffron Walden to belong to the London Section so that they may participate fully in the affairs of its recently established Cambridge Sub-Section.

Dalton Lecture.—The Eleventh Dalton Lecture, entitled 'Chemistry in Everyday Life—the Contribution of the Department of Scientific and Industrial Research,' will be given by Sir Harry Melville, K.C.B., F.R.S., on 28 October at 7 p.m. in the Manchester Town Hall (by kind permission of the Lord Mayor and Corporation of the City of Manchester). The Chairman is Mr E. Le Q. Herbert, *President*, and the Principal Guest will be the Lord Mayor of Manchester, Alderman Arthur Donovan, J.P. Admission is by ticket only, obtainable from the Hon. Secretary of the Manchester and District Section, Mr R. Shackleton, Magnesium Elektron Ltd, P.O. Box No. 6, Lumm's Lane, Clifton Junction, Swinton, Manchester.

Humphry Davy Lecture.—Professor V. N. Kondratiev, Member of the U.S.S.R. Academy of Sciences, has agreed to give the Second Humphry Davy Lecture at the Royal Institution, 21 Albermarle Street, London, W.1, on Wednesday, 12 October at 7 p.m. The title of the address will be 'Energy Exchange in the Interaction of Particles under Electric Discharge.' Light refreshments will be available from 6.30 to 7 p.m.

Conference of Liaison Officers in Technical Colleges.—The third national conference of Liaison Officers was held in Queen Elizabeth College, London, on 2 July, the Chair being taken by the President. The meeting was attended by 81 Liaison Officers and a number of representatives of the Institute, including Professor H. Burton, Hon. Treasurer; Dr C. W. Herd, Vice-President; Mr G. Dring, Dr F. A. Robinson and Dr R. E. Parker, Members of Council; Dr C. C. Addison, Professor C. W. Davies and Dr A. G. Sharpe, Examiners; Dr T. Henshall, Dr A. G. Lindsey and Dr L. Saunders, National Certificate Assessors. Mr A. P. J. Edwards, Secretary to the Postgraduate Training Awards Committee of the Research Council, D.S.I.R., and Mr J. Maitland-Edwards, Staff Inspector, Ministry of Education, attended by special invitation.

Mr A. P. J. Edwards opened the Conference by initiating a discussion on the value and scope of research studentships, advanced course studentships and research fellowships awarded by the D.S.I.R., with particular reference to their availability in technical colleges. The remainder of the morning session was devoted to a discussion of the suggestions put forward by Council for a possible new grade of Institute membership and category of affiliation. It seemed to be generally agreed that the introduction of the proposed Licentiate grade at a good 'pass' degree level would be welcomed in the colleges, but there was little or no support for making separate provision for those students who obtain a 'bare' H.N.C., by the formation of a registered chemical assistants group affiliated to the Institute. Most of the afternoon was devoted to examining problems connected with the Graduate Membership examination and the revision of the *Study Guide*.

The presence of some of the Examiners and National Certificate Assessors was especially welcomed by the Liaison Officers, and it was generally agreed that the Conference had provided another welcome opportunity for an exchange of views.

An excellent luncheon in the College played its part in the success of the Conference.

PERSONAL NOTES

Senior Members

The congratulations and good wishes of the Officers and Council have been sent to the following, who have been corporate members for the periods stated:

70 *years*

Professor J. J. SUDBOROUGH

65 *years*

Mr H. E. BOWLES
Mr F. Robertson DODD
Dr F. H. CARR, C.B.E.

60 *years*

Mr Alexander DAVIDSON
Mr Thomas TICKLE
Mr Lewis EYNON
Mr H. J. WINCH
Mr Harold HALL

55 *years*

Mr J. W. BRISBANE
Mr J. A. GOODSON
Mr A. E. BROWN
Mr J. S. HILLS
Mr P. H. CARPENTER, C.I.E., O.B.E.
Mr G. W. JAMES
Dr P. E. SPIELMANN
Mr R. M. FILMER, M.B.E.

50 *years*

Mr F. L. BASSETT
Mr H. R. LYELL
Mr B. M. BROWN
Dr G. F. MORRELL
Professor F. CHALLENGER
Mr W. T. MUNRO
Mr C. L. L. CLAREMONT
Dr J. R. NICHOLLS, C.B.E.
Major Stanley ELLIOTT, O.B.E., T.D.
Mr G. C. PETRIE
Dr Alexander SCOTT-DODD
Dr Norman EVERS
Mr James SHELTON
Mr C. C. FRYE, O.B.E.
Mr T. A. SIMMONS
Mr C. S. GRACE
Dr Sydney SMITH
Mr H. M. HARVEY
Major J. B. SOLOMON, M.C.

Honours and Awards

Professor Sir Cyril Hinshelwood, O.M., P.R.S., *Fellow*, has been elected a Foreign Associate of the U.S. National Academy of Sciences.

Mr H. R. Jameson, *Associate*, has had the Insignia Award in Technology of the City and Guilds of London Institute conferred on him.

Dr N. J. L. Megson, *Fellow*, senior principal scientific officer at the Royal Aircraft Establishment, Ministry of Supply, has been awarded the first Gold Medal of the Plastics Institute.

Mr J. A. Oriel, C.B.E., *Fellow*, consultant on technological education to the Shell International Petroleum Co. Ltd, has been appointed to an Extraordinary Fellowship of Churchill College, Cambridge, from 1 October.

Dr J. B. Stenlake, *Fellow*, senior lecturer in pharmaceutical chemistry at the Royal College of Science and Technology, Glasgow, has been awarded the degree of Doctor of Science by the University of London, for his work in medicinal and pharmaceutical chemistry.

Professor C. S. Whewell, *Fellow*, Professor of Textile Technology, University of Leeds, has been awarded the Textile Institute's Warner Medal in recognition of outstanding work in textile science and technology.

Consultants

Dr H. G. Harvey, *Fellow*, formerly principal research chemist and head of the liaison advisory unit of the British Food Manufacturing Industries Research Association, has now set up in practice as a specialist consulting chemist, technologist and analyst. His special fields include the investigation of physico-chemical properties and processes, and the application of the results of research on a wide range of foodstuffs. Dr Harvey's address is 4 Gorsey Road, Wilmslow, Cheshire. Tele. WILmslow 5906 (London tele. SHE 5237).

Mr F. A. Lyne, *Fellow*, Honorary Secretary of the Association of Public Analysts, has joined the consulting practice of Mr J. A. Radley, *Fellow*, as head of the analytical section. His new address is Radley Industrial Research and Development Laboratories, 220 Elgar Road, Reading.

Educational

Dr F. N. Aylward, *Fellow*, head of the department of chemistry and food technology at the Borough Polytechnic, London, has been granted leave of absence to enable him to visit Ghana for about six months on behalf of the nutrition division of the Food and Agriculture Organization of the United Nations. During his absence, Dr S. Cotson, *Associate*, principal senior lecturer, will be in charge of the department, assisted by other senior lecturers, Dr D. B. Smith, *Associate* (biochemistry and food technology), and Mr J. E. Proctor, *Associate* (polymers, chemical engineering).

Dr H. W. Douglas, *Fellow*, has been appointed senior lecturer in inorganic and physical chemistry at the University of Liverpool.

Mr J. A. Eggleston, *Fellow*, formerly divisional analyst of the standards department of Boots Pure Drug Co. Ltd, Airdrie, is to take up an appointment in September as chemistry master at the Methodist Boys' High School, Oron, Eastern Nigeria.

Dr M. H. Khundkar, *Fellow*, formerly reader in chemistry, University of Dacca, Pakistan, has been appointed Professor and head of the department, with effect from 1 July.

Mr F. C. Marrison, *Fellow*, until recently deputy director of scientific control at the National Coal Board, is to take up a teaching appointment in Madras for the year 1960–61) in September.

Dr D. B. Mulholland, *Associate*, has been appointed head of the department of chemical engineering at West Ham College of Technology, and will take up his duties in September.

Dr V. S. K. Nair, *Associate*, has been appointed senior lecturer in chemistry at the College of Advanced Technology, Birmingham, with effect from 1 September.

Public and Industrial

Mr J. N. Banfield, *Fellow*, has been promoted to the grade of principal scientific officer, Chemical Defence Experimental Establishment, War Department.

Dr K. S. Chari, *Associate*, assistant director of the Regional Research Laboratory, Hyderabad, India, has returned to Hyderabad after seven months in France under the Indo-French Technical Co-operation scheme.

Dr E. G. Cox, T.D., F.R.S., *Fellow*, has resigned the Chair of Inorganic and Structural Chemistry, University of Leeds, on assuming the Secretaryship of the Agricultural Research Council.

Mr R. H. Doggett, *Associate*, is now engaged on technical and commercial research at the Baupte factory of S.A. des Techniques Industrielles des Algues, Neuilly-sur-Seine, Paris. He was formerly with Messrs Stokes & Son (Analytical and Consulting Chemists).

Dr G. B. Hargreaves, *Associate*, is returning to England in August, and will take up a research post at the Billingham division of Imperial Chemical Industries Ltd.

Dr T. Harrington, *Fellow*, joint managing director of Hickson and Welch Ltd, has been appointed vice-chairman of Hickson and Welch (Holdings) Ltd.

Dr W. E. Harris, *Associate*, has been appointed divisional marketing director of the No. 6 Area, South-Western Division, National Coal Board. For the past five years he has been assistant area general manager.

Mr H. W. G. Hignett, *Fellow*, has been appointed managing director of Henry Wiggin & Co. Ltd.

Mr F. A. Jackman, *Fellow*, has been elected President of the National Benzole and Allied Products Association.

Mr G. M. Lambert, *Associate*, has been transferred to the technical service department of Allied Colloids (Manufacturing) Co. Ltd. He was formerly senior research chemist in the research and development department.

Mr R. Lant, *Associate*, has been appointed joint managing director of Edward Taylor Ltd, Monton, Eccles. He was formerly technical director.

Mr G. B. Lawson, *Associate*, is now employed by Glaxo Laboratories Ltd, Ulverston, Lancashire. He was formerly with Mitchells & Butlers Ltd, Cape Hill Brewery, Birmingham.

Dr E. M. Reid, *Fellow*, was recently appointed president of the Belfast Chamber of Commerce. He has also been appointed managing director of Richardsons Chemical Manure Co. Ltd, Belfast, and of the Ulster Manure Co. Ltd, Londonderry.

Dr P. C. Spensley, *Fellow*, assistant director of the Tropical Products Institute, is to act as director from 1 July until Mr E. S. Hiscocks, *Fellow*, takes up his duties towards the end of the year.

Dr H. A. Thomas, *Fellow*, marketing manager (technical) of the Marketing Division, Courtaulds Ltd, is chairman of the working committee of the Second World Congress of Man-made Fibres, which is to be held in London on 8-11 May, 1962, under the auspices of the International Rayon and Synthetic Fibres Committee.

Dr V. D. Tughan, *Associate*, has been appointed assistant chief chemist to the Gallaher group of companies. He was formerly research chemist.

Dr T. F. West, *Fellow*, has been appointed editor of *Chemistry and Industry*, the weekly journal of the Society of Chemical Industry, and will take up his new duties shortly. He is at present European Operations Executive of the African Pyrethrum Technical Information Centre Ltd.

Nuclear Safety Advisory Committee.—Sir Alexander Fleck, K.B.E., F.R.S., *Fellow*, has been appointed chairman of the Nuclear Safety Advisory Committee, who are to advise the Government on the safety of nuclear installations. Other members of the committee include Sir John Cockcroft, O.M., K.C.B., C.B.E., F.R.S., *Honorary Fellow*, and Sir William Slater, K.B.E., F.R.S., *Fellow*.

Scientific Advisory Council.—The Minister of Power has reconstituted the Scientific Advisory Council and amended its terms of reference, renaming it the Advisory Council on Research and Development. The chairman will be Sir Alexander Fleck, K.B.E., F.R.S., *Fellow*, and members include Dr C. M. Cawley, C.B.E., *Member of Council*, and Sir Harry Melville, K.B.E., F.R.S., *Member of Council*.

Retirements

Miss E. I. Beeching, *Fellow*, has retired after 25 years' service with Mars Ltd.

Mr Adam Dunsmore, *Fellow*, has retired from his position as Area Manager of the Wilts. United Dairies Ltd, Uttoxeter, Staffordshire.

Professor F. H. Garner, O.B.E., *Fellow*, has retired from the Chair of Chemical Engineering in the University of Birmingham.

Mr F. J. T. Grigg, *Fellow*, director of the Dominion Laboratory and Dominion analyst, D.S.I.R., Wellington, New Zealand, has retired.

Professor A. D. Monro, *Associate*, Associate Professor of Chemistry at Victoria University of Wellington, New Zealand, has retired.

Mr R. P. St J. Watkins, *Fellow*, deputy government chemist, Lagos, Nigeria, has retired and returned to this country.

Mr S. H. Wilkes, M.C., *Fellow*, H.M. senior chemical inspector of factories, retired on 30 June.

NEW TELEPHONE NUMBER

As from 15 September the Telephone Number of the Institute will be LANGHAM 3482.

Section Activities

CUMBERLAND AND DISTRICT

Geological Excursion. On 28 May a party of members and friends assembled between Threlkeld and Troutbeck on the main Penrith–Keswick Road, where notes and maps were distributed and a brief indication given of the scope of the excursion.

The party then proceeded by car through Mungrisdale Village, Bowscale, to Mosedale; here they branched off by the track up the valley of the River Caldew to Swineside, where, with some little difficulty, all cars were parked and members then had a picnic lunch by the river in pleasant surroundings and in perfect weather.

The main party then divided, and the first group, led by Mr N. Thomson, went up the Grainsgill Valley and examined the variety of mineral outcrops and old workings which are so well-known to mineralogists. They worked up to the head of Brandygill and over the high ground and down into Drygill, where they were fortunate to see some professional mineral collecting in progress. Meanwhile, the other party were led up the somewhat steep slope of Carrock Fell to the summit, where some time was spent in examining remains of a considerable pre-Roman hill fort. Visibility was fair, and the dominant geological and physical features of many of the Lake District fells could be pointed out, and at a greater distance the outlines of the Galloway Hills and a glimpse of the Cooling Towers of Chapelcross could also be seen. The party then traversed the ridge of high ground until they reached Drygill Head, where they joined the other group. The return was down Brandygill and Grainsgill once more.

A few of the less energetic members of the party had remained in the valley, and at least two people swam in one of the larger pools of the river.

The main purpose of the excursion was to demonstrate the remarkable variety of geological structures, rocks and mineral deposits found in this small area. This included the out-crops of the Skiddaw Slates, the more rugged outlines of the fells composed of Borrowdale volcanic rocks which could be seen in the distance, distant views of the limestone and carboniferous rocks to the east and particularly the complex of igneous rocks of which Carrock Fell is composed. In the Grainsgill zone attention was drawn to the peculiarly modified Skiddaw granite with its associated mineral veins and metamorphic effects on the surrounding slate. In Brandygill and Drygill interesting features were a variety of secondary mineral deposits derived from the primary mineral veins both of the north and south system of Grainsgill and the roughly west–east system of the Caldbeck Fell area. It was possible to see and collect small specimens of many of these minerals. In Drygill the special feature is the occurrence of the complex

arsenical lead phosphate mineral called campylite, which is relatively abundant, and several members examined and to some extent explored an open-cast working where the vein is exposed.

Of the very large number of minerals known to occur in this small area the following were actually seen and specimens obtained by some members: quartz, mica, galena, calcite, chalcopyrite, mispickel, pyrrhotite, molybdenite, wolfram, scheelite, joseite, malachite, apatite, pyromorphite, bayldonite, linarite, goethite, campylite, psilomelane and barytes.

In addition, many characteristic rocks of this area were also examined, including gabbro, granophyre and greisen, the altered Skiddaw slates and the fossiliferous Drygill shales.

The party returned to Swineside, and then proceeded to Mosedale, where the excursion ended with tea at Amber House.

The good weather and general arrangements seem to have made this one of the most successful outings of the Section in recent years.

DUNDEE AND DISTRICT

Annual General Meeting. At the Annual General Meeting held on 6 May the following Officers and Members of Committee were elected: Chairman, Mr J. Wylie; Vice-Chairman, Dr D. G. Neilson; Hon. Secretary, Dr K. R. Hargreaves; Ordinary Members of Committee, Dr R. Roger and Messrs D. R. Brown, W. Johnston, N. B. B. Johnstone and R. S. Nicolson; Mr J. Smart (retiring Chairman) and Dr M. B. Watson (District Member of Council), Members of Committee *ex officio*; Hon. Auditor, Mr J. C. Smith.

Electronic Digital Computers. On 22 April, Dr E. T. Stewart, of Queen's College, Dundee, delivered a lecture entitled 'Chemical Applications of Electronic Digital Computers.' Confining his lecture to purely arithmetical applications, Dr Stewart suggested that most chemists whose work involves only occasional bursts of computational activity have not realized how straightforward the use of electronic computers has become in the past few years. To show how quickly the required techniques can be learnt, he considered in detail the power-series expansion of exp x, and so brought out all the essential elements in automatic computation, especially the highly repetitive character of an efficient programme.

After examining various ways of solving linear and non-linear simultaneous equations of the type that arise in kinetic, thermodynamic, quantum-chemical, or statistical studies, Dr Stewart concluded his lecture by pointing out that nowadays it is seldom necessary to impose artificial restraints on experimental conditions merely to avoid consequent computational difficulties.

After a short discussion, Mr I. R. McGregor proposed a vote of thanks to the lecturer.

Confectionery Making. On 25 March Mr D. R. Brown, of James Keiller & Son Ltd, Dundee, delivered a lecture entitled 'The Chemist and Confectionery Making' at Dundee Technical College.

The lecturer traced the development of the confectionery industry, and outlined the stringent chemical controls essential for the production of chocolates, sweets and marmalades in modern times. The lecture was illustrated with coloured slides, and the audience sampled various confectionery products to their satisfaction.

After question time, Mr N. B. B. Johnstone proposed a vote of thanks to Mr Brown.

GLASGOW AND WEST OF SCOTLAND

Works Visits. On 2 June a small party of members visited Roche Products Ltd at Dalry, Ayrshire. After a preliminary talk by Mr W. Hudson, works chemist, on the manufacture of vitamin A, the party split up into sections which were conducted through the works by members of the staff. The process involved in the manufacture and control of purity of vitamin A was displayed, and after an excellent informal tea the visit ended with a vote of thanks by Dr J. Sword.

On 9 June a group of members visited the Glasgow factory of James Templeton & Co. Ltd, carpet manufacturers. The visitors were shown the processes involved in the manufacture of spool Axminster carpets, and were later conducted around a display of the company's products. A vote of thanks for the company's hospitality was proposed by Dr W. Gibb.

On 22 June members of the Section visited the nuclear power station now under construction at Hunterston on the Ayrshire coast. Members of the staff of Kennedy and Donkin, Consultant Engineers, showed small parties over the site, which was impressive even in its present raw state. The visitors were able to see stages in the fabrication of the steel pressure vessels for the reactor cores and the boilers or heat-exchangers. The unique system of refuelling on load by means of a charge-machine sited below the reactor was explained. The general layout of the station—reactor buildings, generator house and ancillary structures, such as a cooling pond for discharged fuel elements, water intake and outlets—was conveniently seen from a vantage point high on one of the reactor buildings. A contributory factor to the very successful visit was the coach trip from Glasgow through the very pleasant Renfrewshire and Ayrshire countryside. The visit ended with a vote of thanks by Professor P. D. Ritchie, F.R.S.E.

Gold Making and Faking. On 8 June the tenth Annual Junior Lecture was delivered to more than 400 senior pupils from secondary schools in Glasgow and the surrounding districts. The lecture was held in the Chemistry Department of the University of Glasgow, with Dr W. A. Caldwell as Chairman. Dr A. Kent, the lecturer, spoke about the colourful incidents and

people involved in the attempt to produce gold form cheaper metals. The very nature of the subject was such as to cause a departure from the practice of previous years in that practical demonstrations were absent, but the lecture, adequately illustrated with slides, more than

By courtesy of Associated Newspapers Ltd.

made up for this. The vote of thanks was proposed by Mr Thomas Anderson of Hutchesons' Boys' Grammar School, Glasgow.

LEEDS AREA

Grades of Membership. A Special Meeting of the Section was held at the University of Leeds on 13 June to consider the questions of a possible new grade of membership and of a category of affiliation. Mr R. K. K. Fourness, Chairman of the Section, presided, and there was a large attendance.

Dr G. R. Ramage, Vice-President, opened the discussion by sketching the background of the Council's approach to the problems, and in so doing he stressed the importance which Council attached to the views of members up and down the country. The Licentiateship had been suggested because it was felt that the Institute was big enough, in every sense of the word, to accede to the growing demand for some recognition of the value of two years' full-time or equivalent part-time study as against the three years necessary for the Associateship. If Licentiates were to be non-corporate members, *i.e.* full members with restricted or no voting powers, the rights and responsibilities of the Fellows and Associates would be sufficiently safeguarded.

In the ensuing discussion a number of members emphasized that the character of industry was changing rapidly and that great numbers of young men, who had attained only pass degree level and therefore could not aspire to the Associateship, had developed into sound practical chemists and were occupying positions of considerable technical responsibility. These people must be recognized and retained within the professional ambit and some appropriate insignia must be devised for them, while at the same time the standards of our full qualifications must be maintained. Although proposals for a third grade of membership had proved unacceptable in the past, the time had come when the Institute could no longer sustain its insistence on depth rather than breadth of knowledge as the essential professional requirement.

A few members feared that a third grade of membership with a lower standard of qualification would weaken the profession and adversely affect salaries and conditions of service. If such people were indeed worthy of professional recognition, they were being handicapped by the steadily increasing difficulty and specialization of the Associateship examination.

On the question of the voting rights of Licentiates it was pointed out that there were other societies which were governed by representatives from all classes of membership; in the Institute the effects might be unfortunate, but lower-qualified people should have some form of minority representation. There was considerable support for some voting rights being given.

A resolution approving in principle the Council's suggestions for the establishment of a Licentiateship was carried by a large majority.

Dr Ramage then dealt with the suggestion to form an affiliated group of Registered Chemical Assistants. There were very many people for whom the Higher National Certificate in Chemistry represented the academic ceiling, and since the Institute was partly responsible for this qualification it ought to provide some form of recognition.

Some members thought that if the H.N.C. were worthy of any kind of professional recognition it should be through the Licentiateship, but it was pointed out that the latter required additional qualifications by way of preliminary education and ancillary subjects which did not necessarily go with the H.N.C., and that only the cream of H.N.C. holders would be likely to pursue further study. The consensus of opinion was that recognition by means of a register would be of little value and would not be considered to be worth the payment of a fee. A resolution approving in principle the formation of such a group was decisively defeated.

LONDON: SUMMER VISITS

The Royal Mint. On 5 May members of the Section visited the Royal Mint. The party was welcomed by Dr J. H. Watson, in the absence of Mr E. G. V. Newman, deputy assayer, who had arranged the details of the visit. Four scientific officers, Messrs Bunton, Dunning, Harvey and Warden, took the members on a comprehensive tour of the sections dealing with the production of bronze, brass and cupro-nickel coinage.

Members were also shown stages in the production of dies from the artists' casts for coins and medallions, and

the visit ended with an inspection of the Assay Office and the Museum.

Tea was kindly provided by the hosts, to whom a vote of thanks was proposed by Mr N. Lindop.

Warren Spring Laboratory, Stevenage. On 10 May the Warren Spring Laboratory at Stevenage was visited. The party was welcomed by the Director, Mr S. H. Clarke, who outlined the reasons which led up to the opening of this new concept in D.S.I.R. establishments in 1959, following the closure of the old Fuel Research Station at Greenwich. Its terms of reference are wide and intentionally maintained reasonably elastic so that it shall be an establishment deliberately geared to serve the needs of industry. It was therefore unlikely that the main emphasis of its work would remain constant, for it was bound to change according to needs. At present five main programmes were in hand, the first two of which were a continuation of work previously carried on at Greenwich, namely the measurement and abatement of atmospheric pollution and chemical process development, arising from many years of work on the Fischer–Tropsch synthesis. Of the newer programmes, perhaps the largest was that on mineral processing, which was proceeding at pilot-plant scale, but a notable addition to the resources of the establishment was the incorporation of the chemical engineering section it had taken over from the C.R.L. at Teddington. Finally, studies of the human sciences on a positive basis were being initiated to augment the rather more academic approaches being pursued with Government assistance in the Universities.

The visitors, divided into four small parties, were then taken round those parts of the establishment which were considered to be of the greatest interest to chemists. General chemical and analytical work is carried out by the physical and chemical service division, where the laboratories are a model in space and lay-out. The chemical section includes one laboratory built to Harwell standards of ventilation, and so on, for the analysis and examination of radioactive materials. Large pilot-scale buildings are available with excellent head room for plant erection. The Fischer–Tropsch units are housed in part of these buildings, the remainder being used by the chemical engineering research division and for work in connection with the Clean Air programme.

Process development is centred upon a basic study of the factors which control catalyst activity, with particular reference to iron oxides, and the properties of pure haematite are first being investigated. The krypton absorption method is used to measure surface area in assessments of activity.

The mineral-processing division has one laboratory devoted almost entirely to studies of surface chemistry, and its application to flotation processes. Here work is proceeding on the measurement and interpretation of surface potentials as related to these operations.

When the visitors finally assembled in the library, and an opportunity had been given for a few questions on what had been seen, Mr P. A. Raine thanked the Director and all concerned for a most interesting afternoon.

Messrs Baird & Tatlock (London) Ltd. On 17 May, a party visited the Higham Lodge Works of Messrs Baird & Tatlock (London) Ltd at Walthamstow. With Messrs T. F. W. Lawrence, R. Wales and I. Ward as guides, they were taken on a tour of the wide range of manufacturing facilities.

In the metal-working shop the party saw a variety of machines producing components for many articles, including laboratory ovens, incubators, autoclaves and bomb calorimeters, followed by assembling and the application of finishes. The testing of autoclaves aroused much interest, the ease of handling of modern types being particularly noticeable.

In the instrument shop, members were shown the production and assembling of components for various instruments, such as zone-refining apparatus and auto-titrators. The manufacture of the perspex cell for the latter and the complicated switching required were of particular interest.

The glass-blowing shop was then visited. This craft is always of interest to chemists and some difficulty was found in persuading the party to complete the tour in the time available. The manufacture of sintered glass diaphragms and the graduation of volumetric apparatus were included in this section. The tour concluded with a brief look at the research and development section.

Over tea the parties were able to discuss points of interest with their guides. Although there was no opportunity for a formal expression of thanks to the hosts, at the conclusion of the visit Mr Lawrence, who organized the afternoon, was personally thanked for his untiring efforts and asked to convey the thanks of the Section to his fellow guides and to the works manager, Mr G. Spraggon, for his assistance.

The Royal Observatory. On 20 May a party made an interesting visit to the Royal Observatory, Herstmonceux, Sussex.

The Royal Observatory (founded in 1675) was originally housed at Greenwich, and moved to its delightfully picturesque surroundings a few years ago.

The party first visited the Equatorial Section, and saw a modern reflecting telescope fitted with an aluminized mirror and used mainly for recording photographically the spectra (ultra-violet and visible region) of stars. The photographs give information concerning the speeds of stars observed. The relative merits of reflecting and refracting types of telescopes and other particulars were explained in an interesting manner by Mr J. B. Alexander, who acted as guide. One advantage of a mirror is that it can be supported at the back, whereas a lens can only be supported at its periphery.

The party was then shown a 13-in. refracting telescope used mainly for detecting photographically the relative 'shift' of stars which becomes evident on comparing photographs of the same stars taken over a period of very many years.

The various devices operated manually and electrically to control telescopes and equipment were shown and explained. Electronic recording equipment was also shown. The visitors saw how the dome is rotated, and in another instance how the whole circular flooring beneath a large telescope can be raised or lowered through several feet while people are standing on the floor.

An inspection was made of the 'time section', including 'quartz crystal' clocks of extreme accuracy, the reception of time signals by radio and the provision of landline time-signals for the B.B.C. time-signal 'pips.' Clocks showing Sidereal Time and G.M.T. were also seen.

At the conclusion of the visit, Mr J. R. Barr expressed the party's sincere thanks to the Astronomer Royal and members of the Royal Observatory staff for the facilities provided.

Johnson, Matthey & Co. Ltd. A party was taken round the Royston, Hertfordshire, works of Messrs Johnson, Matthey & Co. Ltd on 24 May. They had the satisfaction of seeing in bulk a great deal of the periodic table of elements which normally is only read about, or at most seen in tiny specimen tubes.

Crude silver is refined electrolytically to 99·99 per cent purity, and cast into large ingots. Dissolving in nitric acid is now a 'fumeless' process, the nitric oxide evolved being reacted with oxygen (not air) and reconverted into nitric acid within the plant (patented process). Silver nitrate for photographic emulsions has to be of the highest purity. Silver plating and alloying also demand high-purity starting material, and gold and other more precious metals are recovered during refining.

Some gold bars are cast to a highly precise weight, no subsequent filing off of any excess being permissible. The fact that one can hold a 400-oz gold bar worth several thousand pounds in the palm of one's hand emphasizes the security problems of a precious-metal works and its transport services. The sight of molten gold being poured into numerous moulds from a single tipping furnace was impressive.

So was the casting of molten platinum into 'grain' by tipping into water, and the forging and rolling of white-hot ingots of platinum. These are the preliminaries to the drawings of wire and the making of gauze from very fine wire. Platinum was present in many forms—rod, sheet, vessels, powder and sponge—as well as a variety of alloys and salts.

Rhodium, palladium and several others added to the bewildering variety of precious metals refined to very high purity. Rhodium plating (over silver plating) for radar equipment as well as for ornaments was of special interest. 'Crude' germanium already contained impurities only in the part-per-million range, and was refined by zone-refining technique to the standard of electrical resistivity needed for transistor manufacture. Practically all the individual rare-earth oxides are supplied free from contamination by the others, separation being effected in ion-exchange columns.

Assaying and control are vital in all these operations, and chemical methods are supplemented by optical and X-ray spectrograph.

Dr S. A. Miller expressed the thanks of the visitors to Mr B. Wilson, the works manager, the guides and members of the staff for an instructive and interesting tour.

British Insulated Callender's Cables Ltd. On 1 June a party visited the power cables division of the company. The party saw first the general methods of making paper-insulated cables, a number of stranding machines for making and shaping the conductors being inspected, and also the application of paper insulation in the form of tape. The party was then shown some very interesting equipment for making high-tension cables in which the whole machine operates in an atmosphere controlled at very low humidity. Impregnating equipment and extruding machines for lead and plastic sheaths were also seen in operation.

In the chemical laboratories a series of demonstrations had been arranged showing tests, both chemical and physical, used in the examination of cable-making materials. Finally, the high-tension testing laboratory was visited. This is a very impressive building, believed to be the largest of its kind in Europe, capable of test pressure up to 3·2 MV.

The visit ended with the serving of refreshments, during which Dr T. Dewing expressed the thanks of the party for a very interesting visit, particularly to Mr Fisher and his fellow guides for their detailed explanations of the various operations.

Brewing Industry Research Foundation. On 2 June members of the Section spent an interesting afternoon at the laboratories of the Foundation, Lyttel Hall, Nutfield. Lyttel Hall is in a beautiful setting, and the banks of rhododendrons on a wonderful summer day added to the enjoyment of the occasion.

The visitors were welcomed by Dr Findlay, assistant director, who apologized for the unavoidable absence of Dr Cook, and briefly outlined the aims and organization of the Foundation. It is completely independent of government aid, is supported by the brewing industry, and exists to further basic knowledge on the materials used and processes involved. It is the only institution of its type in the world, and is carrying out fundamental work on the many aspects of brewing that are outside the scope of industrial or consultant laboratories. Dr Findlay emphasized that the Foundation does not generally deal with day-to-day problems of the industry,

but is far more occupied with long-term investigations, *i.e.* it is not a 'trouble shooting' organization.

The visitors, divided into three groups, were then shown several aspects of the work. The experimental malting department carries out as a matter of routine the assessment of new barleys, and is particularly concerned with methods for the reduction in root growth during the malting process. Some success has been achieved by the use of additives in the steeping bath, but modifications to the malting cycle, involving double steeping periods of reduced time, are a far more promising course of action. These can have the combined effect of reducing the extent of root growth and cutting down the number of days required for the malting operation.

Perhaps the most interesting practical demonstration seen was that of the miniature continuous brewing plant. Continuous fermentation is already in operation in certain breweries, but in this plant the whole process from grinding dry malt to racking of the finished beer is continuous. Mashing takes place in a circular segmented continuously-rotating mash tun, and hopping is carried out by extraction on a slowly moving belt by circulating wort from boilers. This is followed by continuous fermentation in stirred vessels, on already established principles.

The Foundation has a fully equipped and flexible small-scale brewery employing batch processes. Here the normal problems of brewing are studied, and particular attention is being given to the prevention of haze. Among the manifold causes of haze, the presence of polyphenols is regarded as a particular culprit, and samples were displayed which demonstrated the beneficial effects obtained by filtration of the beer through nylon powder.

The analytical section serves the whole of the Foundation, and is also responsible for taste tests, which are in general the final criterion of beer quality. A special room is set aside for this purpose, and taste panels are formed on a highly-organized basis. Work is proceeding continuously on the development of improved analytical methods, and several novel and speedy methods have resulted, particularly in respect of fermentable substances in wort.

In the organic department the major active constituents of hops have now been isolated, and the contributions to the flavour of beer are being studied. The problem is extremely complex, for indications are that the 'bittering principle' is not any one constituent of the hop resins or oils but is partially produced by reaction in the beer.

The microbiology department holds the national collection of yeast cultures, which are completely classified and available not only to the brewing industry but to workers in any field. Information is being obtained on the growth of yeast populations by a method of synchronized culture. By this means a population of even-aged cells becomes available for biochemical studies, and so it is possible to follow the changes in composition of the protoplasm over two division cycles occupying 6-7 hours. This has enabled the protection of D.N.A., R.N.A. and protein in the dividing yeast cell to be studied.

The visitors were entertained to tea, and Mr P. A. Raine thanked the hosts for the excellent facilities they had provided on this visit.

NORTH LANCASHIRE

Special General Meeting. This meeting was arranged for 16 June at Harris College, Preston, so that members could express their opinions on the 'Possible New Grade of Membership and Category of Affiliation' (*J.*, 122). Mr T. E. V. Horsley, Section Chairman, was in the Chair.

Attendance was most disappointing, and few took advantage of the opportunity offered to members unable to attend of informing the Secretary of their views by letter. The Chairman opened the meeting by referring members to the remarks by Mr C. D. Lafferty, the Section representative, at the April Conference of Hon. Secretaries. He then suggested that the notice already circulated be used as a basis for discussion.

The meeting was principally in favour of the formation of a Licentiateship Grade. Some members expressed the view that if it was necessary to cater for the interests of the student who did not achieve the required academic level for admission to Graduate Membership, then the Institute was the only body suitably qualified to undertake this responsibility. However, they were undecided as to the form this should take. A motion that 'the creation of a third grade of membership is desirable' was approved by a large majority. Members expressed the opinion that such a new grade, with the privilege of the use of designatory letters, would increase the prestige of the individual, and be recognized by employers as indicating a more broadly-based education and experience than that offered by H.N.C. alone. Certain members felt that, for example, since the Licentiateship would not enable applicants for situations in the Civil Service to achieve a different grade, *e.g.* Scientific Officer, the extra effort involved would be wasted. This did not, however, take into account the possibility that the applicant would probably have an improved chance of success in securing the position, nor that as a consequence of his wider knowledge his future prospects would be better.

Further discussion led to the suggestion that perhaps the student, having passed his Part I Grad. R.I.C. examination and made application for the Licentiateship, would not bother to proceed to Part II. This was dealt with briefly, since it soon became clear to members that any student making such a decision would do so because of difficult circumstances or because he considered, possibly with the approval of his lecturers, that this was his best course of action. The student who

By courtesy of the 'Falkirk Herald'

intended to enter for the Part II Grad. R.I.C. examination was unlikely to be deterred by a less success.

Suggestions for alternative methods of admission by direct examination were rejected. On the other hand, the suggestions made for admission to the Licentiateship detailed in the *Journal* were all approved.

STIRLINGSHIRE AND DISTRICT

Schools Careers Panel. On 26 April a Careers Panel in Chemistry was held at the Graeme High School, Falkirk. This panel was one of about 30 organized by the Stirlingshire County Education Authority in collaboration with the County Youth Employment Office. The Chemistry Panel was strongly supported by some 300 parents and pupils who came to hear what opportunities existed in the profession of chemistry. The Principal Speaker on the Panel, Professor Frank Bell, F.R.S.E., of the Heriot-Watt College, Edinburgh, was followed by Mr J. F. Walker, Organizer of the West of Scotland Committee on Technical Education, and by Dr M. Pyke, F.R.S.E., and supporting panel members included Mr R. J. Loveluck, Dr A. McLean and Mr G. C. Bailey, all of whom were introduced by the Chairman, Mr J. Cunningham. The great interest in the profession was indicated by the attendance and by the number who asked for a personal interview after the general meeting was closed. The Institute's Mobile Careers Exhibit was displayed and some general publications were available for those wanting them. The picture shows some members of the audience gathered round the Careers Exhibit.

CAPE OF GOOD HOPE

The Annual General Meeting of the Section was held in the Senior Chemistry Lecture Theatre, University of Cape Town, on 27 May.

The following were elected Officers and Members of Committee for the ensuing year: Chairman, Professor J. E. Kench; Hon. Secretary, Mr H. E. Krumm; Hon. Treasurer, Mr W. H. Seath; Members of Committee, Drs R. Arnold, M. Lamchen and A. M. Stephen.

After the completion of the formal business of the evening, the retiring Chairman, Mr H. E. Krumm, addressed the meeting on 'The Dilemma of the Soil Scientist.' He referred to the comparatively small number of outstanding scientists who are attracted to the study of agriculture as a full-time occupation. Many promising students transfer to the purely physical sciences or to industry early in their career, because experimental results in agricultural science come slowly, and so much painstaking work is often lost owing to factors outside the control of the experimenter. Also, salaries in industry are usually higher and the opportunities for promotion more numerous.

The speaker then went on to describe in some detail, and in an entertaining manner, the way in which a randomized block experiment is carried out in the field,

and its accompanying frustrations. The object of the experiment was to ascertain the relative fertilizing values of the following phosphate fertilizers: superphosphate, basic slag, a calcium magnesium phosphate and a low- and high-grade rock phosphate. Treatments were given at two levels, each treatment being carried out four times. This gave a total of 44 blocks, including four controls, each block measuring 18 × 100 ft (1/50 morgen). This method of laying out an experiment gives results (*sic*) which can be analysed statistically, the *sine qua non* of the agricultural scientist.

The lecture concluded with a brief description of the methods employed in estimating available phosphorus in soils and fertilizers, and the many difficulties encountered in interpreting the results. Reference was also made to the determination of phosphorus by the molybdenum blue method in plants and soils.

After Professor L. H. Ahrens had proposed a vote of thanks to the speaker, the meeting adjourned for light refreshments.

MADRAS

Annual General Meeting. The ninth A.G.M. was held on 18 December, 1959, with Professor A. B. Natarajan in the Chair. The office bearers for 1960 are: Chairman, Sri K. R. Srinivasan; Hon. Secretary and Treasurer, Professor K. S. S. Varadan; Hon. Joint Secretary, Sri N. Pichandi; Hon. Auditor, Professor Ninan Varghese.

After tea, Professor Nataragan, the retiring Chairman, gave a lecture on 'Forensic Science in India: its present state and future development.' The Chemical Examinations Department in Madras State, an institution that is 108 years old, and is mainly designed to carry out forensic science, has been made the nucleus of the State Forensic Science Laboratory. It has now been integrated with two other laboratories—the Board's laboratory, which was concerned with the enforcement of Prohibition and Excise laws, and the Police Laboratory, chiefly engaged in examinations of Questioned Documents, Foot Prints, Coins and Currency.

MALAYA

Annual General Meeting. The A.G.M. was held on 23 January in the Library, Department of Chemistry, Petaling Jaya, Kuala Lumpur, when the following were elected to serve on the Committee during the ensuing year: Chairman, Professor Kiang Ai Kim; Hon. Secretary and Treasurer, Dr W. Rintoul; Members of Committee, Messrs I. Dickson, F. G. Conaty, R. C. Norris and H. Butcher and Dr G. A. Watson.

At the Annual Dinner on the preceding evening, the Memorial Medal 1959 was presented by Sir Harry Jephcott, Past President, to Mr Chan Kai Cheong *in absentia*.

News and Notes

RESEARCH GRANTS

Mental Health Research Fund.—A revised version of 'Conditions Applicable to Research Grants' has recently been issued by the Mental Health Research Fund. It gives information on fellowships for those suitably qualified who wish to pursue full-time research work on problems of mental health; there is also a travelling fellowship abroad, awarded annually to a non-medical research student intending to work in a field relevant to mental illness, such as neurochemistry. Full details can be obtained from the Secretary, Research Committee, Mental Health Research Fund, 39 Queen Anne Street, London, W.1.

MEETINGS AND EXHIBITIONS

Analytical Chemistry of Beryllium.—A symposium on this subject was held on 23 June at the Imperial Hotel, Blackpool, organized by the Chemical and Metallurgical Services Department, Salwick, Preston, of the U.K.A.E.A. Those attending included representatives from a number of British industrial organizations, all establishments of the U.K.A.E.A., and members of the staff of the Euratom Commission, Belgium, the Université Libre, Brussells, the Pechiney Cie and the Commissariat à l'Énergie Atomique, France. It is intended to publish the proceedings of the symposium; inquiries should be addressed to Mr J. A. Ryan, Organizing Secretary to the Symposium, Chemical and Metallurgical Services Department, U.K.A.E.A., Production Group, Springfield Works, Salwick, near Preston, Lancashire.

Biochemical Society.—A full-day symposium on The Biosynthesis of Nucleic Acids is to be held in Glasgow on 29 September as part of the 398th meeting of the Biochemical Society on 29-30 September. The symposium has been arranged by Professor J. N. Davidson, F.R.S., and the speakers are M. Grunberg Manago (Paris), E. S. Canellakis (Yale), E. Herbert (Massachusetts), I. R. Lehman (California) and R. M. S. Smellie (Glasgow). Further information may be obtained from Dr P. N. Campbell, Courtauld Institute of Biochemistry, Middlesex Hospital Medical School, London, W.1.

Chemical Institute of Canada.—A symposium on 'Stereochemistry in Organic Reactions' will be held at the University of Alberta in Edmonton on 6-7 September by the Organic Chemistry Division. The symposium will take place in the University's new chemistry and physics building, which will be completed in August, and delegates will be housed in the University's residences. Details may be obtained from Dr R. J. Crawford, Department of Chemistry, University of Alberta, Edmonton, Canada.

City of London College.—The City of London College, in collaboration with the Plastics Institute, has again arranged a series of eight lectures intended for non-technical staff employed by companies in or connected with the plastics industry. The lectures will be held at the College, and begin on 3 October. Full details and application forms may be obtained from Mr A. Fawthrop, Head of the Department of Shipping and Commercial Products, City of London College, Moorgate, London, E.C.2.

Faraday Society.—A general discussion on 'The Physical Chemistry of Aerosols' will be held at the University of Bristol on 13-15 September. Registration is not necessary, but the closing date for applications for accommodation during the conference is 1 September. Application should also be made for advance proofs. Further details can be obtained from the Secretary of the Faraday Society, 6 Gray's Inn Square, W.C.1.

Fastness and Fastness Testing.—The chief scientific event of the Society of Dyers and Colourists this year is the Summer School on 'Fastness and Fastness Testing' to be held at the College of Science and Technology, Manchester, from 10 to 17 September. The non-returnable registration fee for non-members is 3 guineas. The last date for applications is 30 August. Further information may be obtained from the General Secretary, The Society of Dyers and Colourists, Dean House, 19 Piccadilly, Bradford 1, Yorkshire.

Institution of the Rubber Industry.—The Institution plans to hold its Fourth Rubber Technology Conference in London on 22-25 May, 1962, and has set up a programme committee. The proposed main sections are Latex Science and Technology, General Rubber Technology, Rubber Science, and Materials and Products. Authors wishing to submit papers, preferably of new and original work, should inform the Committee by 1 September. Preliminary details are obtainable from the Institution of the Rubber Industry, 4 Kensington Palace Gardens, London, W.8.

Interkama 1960.—The 1960 International Congress and Exhibition for Instrumentation and Automation will take place at Düsseldorf from 19 to 26 October. The congress, organized with the assistance of leading international technical and scientific associations, will discuss the present position of instrumentation and control techniques, and the latest developments in both these fields will be demonstrated at the exhibition. Full details and application forms can be obtained from NOWEA, Dusseldorf, Ehrenhof 4, Germany. The latest date for registration is 15 September.

International Congress on Nutrition.—The Fifth International Congress on Nutrition will be held in Washington, D.C., on 1-7 September. An all-day symposium on 'World Food Needs and Food Resources' will be one of the main features of the scientific programme. The remainder of the programme will consist of seven half-day panel discussions by invited speakers, and special sessions of 10-minute papers reporting unpublished research. Major problems of nutrition throughout the world will be reported and discussed during the meetings. The address of the Secretariat is 9650 Wisconsin Avenue, Washington 14, D.C., U.S.A.

OCCA Exhibition.—The thirteenth technical exhibition will take place on 6-9 March, 1961, in the New Hall of the Royal Horticultural Society, Greycoat and Elverton Streets, London, S.W.1. Sir Cyril Hinshelwood, O.M., P.R.S., will open the exhibition at 3 p.m. on 6 March, and will also be the guest of honour at the Exhibition Luncheon at the Criterion Restaurant. The Exhibition will open at 10 a.m. on the remaining days, and will close at 7 p.m. each day. Full particulars may be obtained from the General Secretary, Mr R. H Hamblin, Wax Chandlers' Hall, Gresham Street, London, E.C.2.

Plastics Exhibition.—The 2nd International macro-Plastic Exhibition will be held in Utrecht from 19 to 26 October. The International Congress on the Technology of Plastics Processing will be held in Amsterdam on 17-19 October. Details of the congress can be obtained from N.V. 't Raedthuys, Tesselschadestraat 5, Amsterdam, Holland. Inquiries about the exhibition should be addressed to Exhibition Consultants Ltd, 11 Manchester Square, London, W.1.

Polarographic Society.—A meeting will be held at the Wolverhampton and Staffordshire College of Technology on 21 September at 2.30 p.m. The subject will be 'The Application of Polarography in Metallurgical Analysis.' Further details may be obtained from Mr R. C. Rooney, British Cast Iron Research Association, Bordesley Hall, Alvechurch, Birmingham.

The Society now has a permanent address for mail; inquiries should be addressed c/o Lloyds Bank Ltd, 36 High Street, Wealdstone, Middlesex.

Research Methods and Instrumentation.—The Tenth Annual Instrument Symposium and Research Equipment Exhibit are to be held on 3-6 and 4-7 October respectively, at the National Institutes of Health, Bethesda 14, Maryland, U.S.A. Topics to be discussed at the symposium include infra-red spectrophotometry, activation analysis, ultracentrifugation and electrophoresis. Further information may be obtained from Mr J. B. Davis at the National Institutes of Health.

Robert Horne Memorial Lecture.—The Fourth Robert Horne Memorial Lecture of the S.C.I., by

Professor F. D. Richardson on 'The Extraction of Metals and the Chemistry of Metals', will be delivered in the lecture theatre, Chemistry Department, University of Bristol, Woodland Road, Bristol 8, at 6.30 p.m. on 29 September. All interested persons are welcome to attend.

Society for Analytical Chemistry.—The Scottish Section of the Society for Analytical Chemistry is to hold a joint meeting with the Polarographic Society and the Caithness Technical Society on 30 September in the Lecture Theatre, Dounreay. Those interested are asked to notify Mr J. Brooks, Analytical Research Section, Research and Development Department, Imperial Chemical Industries Ltd, Nobel Division, Stevenston, Ayrshire.

Spectroscopy and Electronics.—The Department of Extra-Mural Studies, University of Liverpool, has arranged two series of lectures, to be held in the autumn, on 'Optical and Radiofrequency Spectroscopy' and 'Introduction to Electronics.' Fees for the courses are 5 guineas and 4 guineas, respectively. Further information can be obtained from the Director of Extra-Mural Studies, University of Liverpool.

Symposium on Chromatography.—The Société Belge des Sciences Pharmaceutiques is organizing a Symposium on Chromatography on 16-17 September. The theoretical aspects of the subject, as well as its practical applications in various fields, will be considered. A scientific exhibition will be held during the two days, and demonstrations of apparatus are invited. A fee of 100 Belgian francs is being charged. Inquiries should be addressed to the Secretariat of the Société, 11 rue Archimède, Brussels, Belgium, immediately.

PURE FOOD CENTENARY

In 1860 Parliament passed 'An Act for Preventing the Adulteration of Articles of Food and Drink.' This was our first *general* pure food law and, indeed, the first in the world. Our current food laws are founded on it and it has influenced the trend of pure food legislation in other countries. In recognition of this pioneering step taken by Great Britain, the centenary of the Act is being commemorated in September by a Conference sponsored by four of H.M. Ministries and four scientific organizations, of which the Royal Institute of Chemistry is one. The President of the Royal Society is President of Honour of the Conference and Mr E. LeQ. Herbert (President of the Institute) is one of its Vice-Presidents of Honour.

The Executive Committee, under the Chairmanship of Dr A. J. Amos, has arranged a most impressive programme for the paper-reading sessions at the Royal Institution. On the morning of 21 September the Rt Hon. The Earl Waldegrave, T.D., Parliamentary Secretary (Lords), Ministry of Agriculture, Fisheries and Food, will formally open the Conference and welcome the delegates on behalf of H.M. Government, after which the Chair will be taken by the Hon. Mr Justice Lloyd Jacob, who has the distinction of being a Bernard Dyer Memorial Lecturer of the Society for Analytical Chemistry and the Chairman of the Analytical Methods Trust of the same Society.

Two papers will be read at that meeting: 'The 1860 Act and Its Influence on the Purity of the World's Food: Historical Introduction' by Dr J. H. Hamence, President of the Association of Public Analysts, and 'Pure Food for the People: the Manufacturers' Contribution' by Dr E. B. Hughes, Chief Chemist, J. Lyons & Co. Ltd.

On the following morning, under the Chairmanship of Dr A. J. Amos, a paper on 'Pure Food and the Commonwealth' will be given by Dr J. G. Malloch, M.B.E., Scientific Adviser to the High Commissioner for Canada, and 'International Aspects of Pure Food and Pure Food Legislation' will be the subject of a paper by the Deputy Director-General of F.A.O., Dr Norman C. Wright, C.B.

At the closing session on the morning of 23 September, the Chair will be taken by Sir Harry Jephcott, Chairman of the Research Council, D.S.I.R. The subject of each of the first three papers will be 'National Problems' and the speakers will be Dr C. A. Morrell, Director of the Food and Drugs Directorate, Canada; Professor F. H. Reuter, Associate Professor of Food Technology, The University of New South Wales; and Dr G. P. Larrick, Commissioner of Food and Drugs, United States. The final paper will be given by Professor A. C. Frazer, Professor of Pharmacology and Medical Biochemistry, University of Birmingham, and will have as its subject 'The Integration of Food Research.'

The programme of the Conference includes also a series of visits to food factories and to control and research laboratories arranged for the afternoon of 22 September, and a public Exhibition at Charing Cross Underground Station, at which there will be displayed for a period of three weeks a modern food laboratory and one of 1860.

Official delegates and visitors from many countries have registered for the Conference and they are being welcomed on the eve of the proceedings by H.M. Government at a Reception at Lancaster House, at which Earl Waldegrave will act as Host. The Conference will close with a Banquet at the City of London Guildhall on the evening of 23 September.

Registration forms can be obtained from the Secretariat, 14 Belgrave Square, S.W.1, but **applications should not be delayed** because, although there is ample seating capacity at the Royal Institution, the lists of participants in some of the visits and some of the social functions may soon have to be closed.

NATIONAL COUNCIL FOR TECHNOLOGICAL AWARDS

The third Report of the National Council, issued recently, mentions that 100 courses have been recognized at 23 colleges; 92 applications have been declined.

During April, 1959 to March, 1960, 129 students were awarded the Diploma in Technology, bringing the total number to 163, of whom 24 students have gained first-class honours and 100 second-class honours.

There are now 13 courses leading to the Dip. Tech. in applied chemistry, chemical technology or industrial chemistry with 359 students, of whom 163 are in their first year. There are 11 sandwich courses extending over four years, the others being three-year full-time courses. Eight Diplomas in Technology have been conferred on candidates in applied chemistry during this year. Five of these gained second-class honours, the other three were awarded a pass. All these students carried out their academic training at Birmingham College of Advanced Technology, whilst their industrial training was carried out at one of the following organizations: British Industrial Plastics (Chemicals) Ltd, Dunlop Rubber Company Ltd, General Electric Company Ltd, Imperial Chemical Industries Ltd, Joseph Lucas Ltd, West Midlands Gas Board.

The Report refers to the establishment of the College of Technologists in May, 1959, and states that by 31 March nine applications to register as candidates for the M.C.T. had been received.

A memorandum on the industrial training of students following Dip. Tech. courses has also been issued. An Industrial Training Panel was set up during the year to advise on industrial training; the responsibilities of the firms and the colleges in this matter have been defined.

The staffs of colleges offering Dip. Tech. courses in applied chemistry have already given much thought to this matter, and several conferences between representatives of the colleges and industry have been held to discuss the form that industrial training should take.

DIP. TECH. COURSES (CHEMICAL)

(S, Sandwich; FT, Full Time; AC, Applied Chemistry; CT, Chemical Technology; IC, Industrial Chemistry)

*Birmingham, College of Advanced Technology	(S)	AC
Birmingham, College of Advanced Technology	(S)	CT
*Bradford, Institute of Technology	(S)	IC
*Bristol, College of Science and Technology	(S)	AC
*Huddersfield, College of Technology ..	(S)	CT
†Liverpool, College of Technology	(S)	AC
*London, Battersea College of Technology ..	(FT)	AC
*London, Battersea College of Technology ..	(S)	AC
*London, Borough Polytechnic	(S)	CT
*London, Brunel College of Technology ..	(S)	AC
London, Northampton College of Advanced Technology	(S)	IC
Loughborough, College of Technology ..	(FT)	IC
Loughborough, College of Technology ..	(S)	IC
*Salford, Royal Technical College	(S)	AC

* If obtained with 1st or 2nd class honours may afford exemption from the Graduate Membership examination.

† Approval of this course has been accorded by the National Council since their Report was published.

Chemical Plant Instrumentation.—The Association of British Chemical Manufacturers has just published a booklet entitled *Chemical Plant Instrumentation—Some Notes on the Use of Measuring Instruments*. These notes were prepared by the Association's Advisory Committee over the past two years, and have been circularized to its members. They are now brought together in booklet form, and copies can be obtained from the Association at Cecil Chambers, 86 Strand, London, W.C.2, price 7*s*. 6*d*. to non-members of the Association.

Pharmacy and Poisons Act, 1933.—According to a Home Office notice dated 20 July, Statutory Instruments amending the Poisons List and the Poisons Rules are being prepared to give effect to recommendations made to the Secretary of State by the Poisons Board after considering the representations received in respect of the proposed amendments announced in the Home Office Notice of 10 February.

Correspondence

NEW GRADE OF MEMBERSHIP

SIR,—I attended the London Special General Meeting to discuss the proposed creation of an L.R.I.C. Diploma and listened with great interest to the many points raised by the various speakers.

It was noticeable, however, that no representative of the student body voiced any opinion, possibly because, like myself, any student present was slightly overawed by the proximity of so many Fellows and Members of Council. I would therefore crave your indulgence to express myself through the medium of the *Journal*.

One of the objections raised by an early speaker referred to the possibility of the L.R.I.C. holder being regarded as a 'failed Grad. R.I.C.' This may be true, but I can see no difference between a 'failed Grad. R.I.C.' with, and one without, the initials L.R.I.C. after his name. Furthermore, those candidates who have failed the Grad. R.I.C. examination would have some recompense and those who are still studying, some incentive.

This brings me to the second point raised by the speaker, who wondered whether the L.R.I.C. would not encourage students to stop there. My answer to that point is that any student who stopped after L.R.I.C. would probably not have taken (or not have passed) the Grad. R.I.C. examination anyway. In addition, many students who would normally cease studying at H.N.C. level would be quite prepared to continue for an extra year to obtain the L.R.I.C.

There were, however, two speakers who both spoke in the same vein and really horrified me. One of these very proudly (and justly so!) informed us that he had

three degrees all obtained under some hardship and that he had no sympathy with students who either 'could not' or 'would not' pass the Part II examination, and that he did not want to be associated with them. To this gentleman I would point out that if some of those candidates who 'could not' or 'would not' pass the examination had been able to sit for the old A.R.I.C. examination they not only could, but certainly would, have passed with ease.

This, I think, brings one to the crux of the matter, which is that the present Grad.R.I.C. examination is of such extremely high standard that if the L.R.I.C. diploma is not adopted chemists will in effect be penalized not for any academic inability but for having been born too late to take the old A.R.I.C. examination.

Could it be, I wonder, that the Opposition realize, in their hearts, that the proposed L.R.I.C. Diploma requires very nearly the same standard as the old A.R.I.C. examination which gave them their status as chemists, and that the proposed Diploma would make this clear?

CYRIL A. BLAU,
Student Member
143 New North Road,
Islington, London, N.1.

[A report of the Meeting will be published next month.—ED.]

SIR,—The letter from Dr and Mrs Stern (*J.*, 233) has completely overlooked the work done by the Institute of Science Technology and also that of the City and Guilds of London Institute in encouraging the training of science laboratory technicians by providing examinations leading to nationally recognized certificates. A number of centres throughout the country have provided courses, and those based on I.S.T. syllabuses at the Universities of London and Edinburgh have been particularly successful.

In January of this year the two Institutes agreed to merge their examinations at Certificate and Advanced Certificate levels, and in future the City and Guilds of London Institute will conduct examinations on behalf of both Institutes.

In discussions on technician training which took place in 1946, the Royal Institute of Chemistry played a major part in the organization and administration of the meetings which started courses of training for science laboratory technicians, and it was partly owing to a suggestion by Dr Ellingham that an independent body was formed to look after their interests. First known as the Science Technologists Association, it was later reconstituted as the Institute of Science Technology.

If any of your members would like further information I should be very pleased to send it to them.

F. W. L. CROKER,
Hon. General Secretary
Institute of Science Technology,
Imperial College, London, S.W.7.

Obituary

Alfred Brookes. *B.* 20.3.05. *Ed.* West Bromwich Grammar School. All his training and experience were obtained in the research laboratory of British Industrial Plastics Ltd. (B.I.P. Ltd.) He entered the firm as a laboratory assistant in 1920, and in 1926 was appointed official analyst and personal assistant to the late E. C. Rossiter, head of the Research Department. He became senior research chemist in 1936, research and development manager in 1947, and chief chemist in 1953, continuing in a similar post in B.I.P. Chemicals Ltd. He was awarded the M.B.E. in 1946 for his work on the Beetle cements used during the war in plywood boats, gliders and wooden aircraft such as the De Havilland Mosquito. He was co-holder of patents and author of several papers. (*F.* 1956.) *D.* 9.4.60.

Philip Cecil Bull. *B.* 29.1.1889. *Ed.* Harrow School; Imperial College, London, 1909–11; research, University of Münich, 1912–14. He was commissioned to the 8th Battalion of the Suffolk Regiment in 1914 and became a major in 1916. He was awarded the D.S.O. the same year and mentioned in dispatches in 1917. Two years later he became a lecturer in chemistry at the Imperial College and remained there until his retirement. In this capacity he devoted himself to the interests of students, especially to 'keeping them human.' Between the wars he was a leading light in the University of London O.T.C., which he commanded for some years. He set a fine example of unselfish service to his fellow-men, and many generations of students owe much to his inspiration and encouragement. He helped to make good chemists out of the less academically brilliant, and good men out of the less firm of purpose. Great in stature and in strength of character, he had an engaging modesty of manner and the innate qualities of leadership. (*A.* 1927.) *D.* 23.3.60.

George Samuel Heaven. *B.* 4.8.1877. *Ed.* Cheltenham School of Science. He became second assistant in the laboratories at Cheltenham College in 1896, and senior assistant in 1902. He was appointed science master at King Henry VIII School, Coventry, in 1906. Four years later he was awarded the degree of B.Sc. (Lond.), and in 1914 joined Courtaulds Ltd, but left shortly afterwards for work in a national explosives factory, which he eventually managed. Returning to Courtaulds Ltd after the war, he helped to set up a number of new factories, including a cellulose acetate rayon plant at Meadville, U.S.A., and a regenerated cellulose film plant at Bridgwater, Somerset. He was appointed to the Board of British Cellophane Ltd in 1937 and was managing director until he retired in 1948. Throughout his life he maintained a keen interest in education, giving much of his time to various

committees from governing bodies of local schools to the South West Regional Advisory Committee for Further Education. 'He had an engaging personality and made friends wherever he went, but he will be chiefly remembered by those younger people who found him a never-failing source of encouragement and help in the pursuit of their ambitions.' (*A.* 1914, *F.* 1917.) *D.* 13.4.60.

Frederick Elston Jones. *B.* 22.10.03. *Ed.* Bridgend County School; University College, Aberystwyth, 1922–26. He continued at University College for a further two years on research; M.Sc., 1928, D.Sc., 1946. He was appointed a junior scientific assistant at the Chemical Research Laboratory, Teddington, in 1928, and was transferred to the Building Research Station, Watford, as a senior research assistant, in 1930. He was promoted to scientific officer in 1934, and remained at the Building Research Station for the rest of his life. In his later work he devoted much time to the study of alkali–aggregate interaction in concrete and became a recognized authority in this field. This, however, did not diminish his interest in the chemistry of cement hydration and the behaviour of metals in building. His activities in these fields led to many papers in the scientific press and to his presence on several advisory committees. In 1958 he was granted a special merit promotion to senior principal scientific officer. His outside interests were few, but he appreciated and enjoyed music and the arts. As a leader, his decisions were firm and reliable, and although disagreements arose, his opinions were always highly respected by his colleagues. He was a man of great determination and insatiable curiosity. (*A.* 1926, *F.* 1946.) *D.* 5.4.60.

William Donald Mackenzie. *B.* 21.10.1892. *Ed.* Bellahouston Academy, Glasgow; Glasgow and West of Scotland Technical College, 1908–10. He became a student with Tatlock and Thomson, city analysts, in 1908. Three years later he joined Lever Bros Ltd as a chemist, and remained with them, or associated companies, for the whole of his working life, except for the period 1915–18, when he was a prisoner of war in Germany. He went to the company's branch at Mannheim in 1913, and after the termination of the First World War proceeded to Brussels, first as a chemist, then as works manager in 1920 and as technical director in 1925. Five years later, he went to Australia where he remained as technical director until 1939, when he returned to this country, retiring in 1958. (*A.* 1930, *F.* 1933.) *D.* 7.4.60.

Alexander Forbes Macmillan. *B.* 9.3.1893. *Ed.* Royal Technical College, Glasgow, 1911–16. He joined the United Alkali Co. Ltd, St Rollox Works, Glasgow, in 1911 as an assistant chemist, before it was merged with Imperial Chemical Industries Ltd, with whom he remained for the whole of his working life. He became departmental manager of the St Rollox Works in 1916, and chief chemist in 1930. He moved to Runcorn in 1936 on his appointment as plant manager, a position which he held until 1956. (*A.* 1931.) *D.* 14.3.60.

George Macaulay Painter. *B.* 5.11.1885. *Ed.* High School, Trowbridge; Birkbeck College, London (as undergraduate, demonstrator and lecturer), 1900–12, B.Sc. From 1912 until the outbreak of the First World War he was engaged on research. He then joined H.M. Forces, attaining the rank of captain, responsible for the anti-gas training of over 20,000 troops. After the war, he became a lecturer in chemistry at the Municipal Technical College, Portsmouth. Later he was appointed an H.M. Inspector of Technical Schools and Colleges, Ministry of Education, where he remained until his retirement in 1950. He was awarded the M.C. and appointed O.B.E. (*A.* 1917). D. 8.4.60.

Alfred Charles Penney. *B.* 2.5.03. *Ed.* Tottenham County School; East London College, 1921–24; King's College, London, 1924–25. M.Sc. He was appointed science master at the County School for Boys, Gravesend, in 1926, and later became senior science master. During the Second World War he deputized for the headmaster during his absences in the evacuation area. Shortly after the war, he was appointed headmaster at the County Modern School for Boys, Bexleyheath, and a few years later he took a similar post at Erith Technical School, where he remained until his death. (*A.* 1932, *F.* 1944.) *D.* 18.4.60.

Arthur Donald Rieber Pullman. *B.* 12.10.1887. *Ed.* St Peter's College, Radley; University of Manchester, 1908–11. B.Sc. He worked for three years in the laboratory of Mr Thomas Tickle, until 1914, when he enlisted in H.M. Forces. He was discharged the following year and joined the Metropolitan Water Board as a chemist. In 1918 he became first assistant chemist to Oxo Ltd, and in 1921 was appointed assistant chemist at the Explosives Research Department, Woolwich. He was later transferred to the Ministry of Supply and remained in Government service until his retirement. (*A.* 1917, *F.* 1925.) *D.* 21.4.60.

Stanley Robson. *B.* 28.3.1888. *Ed.* Armstrong College (now King's College), Newcastle-upon-Tyne, 1907–13; Imperial College, London, 1913–15. M.Sc. (Dunelm.). His first appointment was as chemist-in-charge of the acids and guncotton sections of the Royal Naval Cordite Factory, and in 1917 he was responsible for the building and operating of a contact plant for the manufacture of sulphuric acid at Holton Heath. In 1920 he became manager of the acids and heavy chemicals section, British Dyestuffs Corporation (now Imperial Chemicals Industries Ltd), and in 1924 was appointed manager of the National Smelting Co. Ltd, later becoming works director, as well as a director of

National Fertilizers Ltd, Imperial Magnesium Corporation Ltd and associated companies. He joined the Imperial Smelting Corporation Ltd in 1943 as director of research and development, and in 1947 became consultant to the Zinc Corporation. He gave up this appointment in 1953 in order to do justice to his honorary secretaryship of the Royal Institution. He also served as president of the Society of Chemical Industry, of the Institution of Chemical Engineers, and of the Institution of Mining and Metallurgy. In 1950 he was made an honorary Fellow of the Imperial College in recognition of his achievements in chemical industry and extraction metallurgy and of his service to past and present students of the Royal School of Mines. 'Kindly, competent, gently humorous and deeply religious, he went through life helping lame dogs over stiles. Always considerate and generous to those who worked for him, he won their respect and confidence by the equanimity of the practical Christianity of his day-to-day life.' (*A.* 1918, *F.* 1944.) *D.* 26.3.60.

Philip John Sageman. *B.* 6.6.1876. *Ed.* Central Technical College, London; Royal College of Science, London. He entered the Government Laboratory as a chemist in 1902 and was taken on the permanent staff in 1906. He left in 1930 on his appointment as Director of the Chemical Department Laboratory, Alexandria, Egypt, where he remained until his retirement in 1939. He was part author of papers in the *J. chem. Soc.* (*F.* 1916.) *D.* 1.4.60.

Charles James Still. *B.* 14.6.1879. *Ed.* St Andrew's School, Belfast. In 1897 he became an apprentice and assistant pharmacist to W. A. Lyness, of Belfast, and in 1901 an assistant pharmacist to Steele and Marsh, of Bath. The following year he was appointed demonstrator and lecturer in chemistry in the newly founded Municipal Technical Institute, Belfast. B.Sc. (Lond.), 1912. In 1917 he was appointed a works chemist at the British Dyestuffs Corporation (now Imperial Chemical Industries Ltd). He returned to Belfast in 1920 to take up the post of lecturer in bleaching and dyeing at the renamed Technical Institute, now College of Technology. He was engaged in research with the late Professor H. Wren, and was awarded the degrees of M.Sc. (Belf.), 1921, and of Ph.D. (Belf.), 1923. He was one of the first members of the Faculty of Applied Science, Queen's University, Belfast, and was appointed extra-mural lecturer and examiner. He retired in 1944. He was a teacher of outstanding merit, beloved by both colleagues and students. (*A.* 1918.) *D.* 6.4.60.

Garfield Thomas. *B.* 5.4.1896. *Ed.* Northern Polytechnic, London, 1915–16, 1919; University of Manchester, 1919–21. B.Sc. His studies were interrupted by service in H.M. Forces, 1916–19. Before entering military service, he was employed during 1915 by Henry Leven, Webb & Co., of Stratford, to whom he returned on his discharge in 1919, before proceeding later the same year to the University of Manchester. He remained at the University a further year to do research and was awarded the degree of M.Sc. He was appointed second assistant in the Clinical Laboratory of Manchester Royal Infirmary in 1923. He became biochemist to the General Hospital, Birmingham, in 1927, transferring to the Queen Elizabeth Hospital when it opened in 1938. He remained there as chief biochemist for the rest of his life. In 1939 he was appointed honorary lecturer in clinical chemistry at the University of Birmingham. He served for many years on the Birmingham and Midlands Section of the Institute, of which he was vice-chairman, 1944–46, and chairman, 1946–48. He was a member of the Rotary Club of Birmingham and his chief hobby was photography. 'He was greatly respected by his colleagues and never spared himself in his professional duties. He was of retiring nature, which often concealed his warm-hearted personality and charm.' (*A.* 1921, *F.* 1940; Council 1941–44.) *D.* 24.3.60.

THE REGISTER

NEW FELLOWS

(R) BERRIDGE, Stephen Arthur, F.INST.PET., M.I.CHEM.E., B.SC. (LOND.)
(J) COTTRELL, Prof. Tom Leadbetter, B.SC., D.SC. (EDIN.)
(P) ILIFF, Neil Atkinson, F.K.T., M.A. (CANTAB.)
(B) MACKLE, Henry, M.SC., PH.D. (Q.U.B.), D.PHIL. (OXON.)
(Q) PRESTON, Gerald Edmund, A.M.C.T., B.SC.TECH. (MANC.)
(D) SMITH, John Oliver, B.SC. (LEEDS)
SUTTON, Leslie Ernest, B.SC., D.PHIL., M.A. (OXON.), F.R.S.
(P) SYKES, William Oliver, B.SC. (SHEFF.)

ASSOCIATES ELECTED TO THE FELLOWSHIP

(J) ANDERSON, Douglas Macdonald Watt, B.SC., PH.D. (EDIN.)
(Q) APLEY, Martin, B.SC. (LOND.)
(OF) BAKORE, Ganesh Vishwanath, M.SC. (AGRA), PH.D. (RAJ.)
(N) BITHELL, Raymond John, A.C.T. (BIRM.)
(N) BRISCOE, Peter Alick, B.SC. (BRIS.), PH.D. (LEEDS)
(H) BROADBANK, Robert William Clayson, B.SC., PH.D. (LOND.)
(P) BROWN, Basil Reginald, B.SC. (LOND.)
(H) BURROWS, Arnold Arthur, B.SC., PH.D. (LOND.)
(P) CHAYEN, Ralph, A.R.C.S., D.I.C., B.SC., PH.D. (LOND.)
(OA) CHIA, Chwee Leong, M.SC. (MALAYA)
(Q) DAGLISH, Anthony Fenwick, M.A. (CANTAB.), PH.D. (DUNELM.)
(V) ELLIS, Percival Francis, M.B.E., M.INST.F., B.SC. (WALES)
(P) GOODER, Harry, B.SC., PH.D. (LEEDS)
(P) GOODSPEED, Jonathan, B.SC. (LOND.)
(P) HOPF, Peter Paul, B.SC. (LOND.)
(Q) JEFFRIES, Roy, B.SC., PH.D. (LOND.)
(H) JOHNSON, Cecil Alfred, B.SC., B.PHARM. (LOND.), F.P.S.
(R) KIDMAN, Sidney Louis
(Y) LATHAM, Kenneth Geoffrey, B.SC., PH.D. (LOND.)
(N) MOORE, John Royston, B.SC. (MANC.)
(F) O'LEARY, John Joseph
(P) PALGRAVE, James Arnold, B.SC. (DUNELM.)
(C) RAINBOW, Cyril, B.SC., PH.D. (BIRM.)
(C) ROBB, Prof. James Christie, B.SC., PH.D. (ABERD.), D.SC. (BIRM.)
(P) SINGTON, Edward Peter Campbell, B.SC., M.A. (OXON.)
(X) TOMLINSON, Russell Frederick, A.M.C.T.
(H) WARD, Edward Raymond, B.SC., PH.D. (LOND.)
(J) WOOD, David Rainforth, B.SC. (EDIN.), A.H.-W.C.

(OC) WOOD, Herbert John, B.SC. (N.Z.)
(P) WOODS, Sydney Derek, M.A. (OXON.)

NEW ASSOCIATES

(P) ACKROYD, Evelyn Alice, B.SC. (MANC.)
(L) BAILEY, Derek, B.SC. (LOND.)
(P) BENNETT, John Graham, B.SC. (LOND.)
(O) BENSON, Denis, B.SC. (LIV.), PH.D. (WALES)
BHARGAVA, Om Prakash, M.SC. (AGRA)
(G) BOOTH, Donald Harold, B.SC. (HULL)
(OF) DHAR, Girdhari Lal, B.SC. (PANJ.), M.SC. (LUCK.)
DREWES, Siegfried Ernst, M.SC. (NATAL)
(R) GRIFFITHS, Trevor Redston, B.SC. (S'TON)
(P) MAZUMDER, Bibhut Ranjan, B.SC. (CALC.), M.SC. (DACCA), PH.D. (HOWARD)
(P) MILKOWSKA, Zofia Barbara, B.SC. (LOND.)
(P) MILLER, David John Anderson, M.A. (OXON.)
(E) NICHOLLS, Paul Joseph, B.SC. (BIRM.), PH.D. (WALES)
(Q) NORRIS, William Lake, B.SC., M.A. (OXON.)
(FF) PATTERSON, James Gardine Jamieson, B.SC., PH.D. (ST AND.)
(P) PAULI, Michael John, B.SC. (GLAS.)
(M) REA, Philip Charles, B.SC., PH.D. (LOND.)
(Q) RICHARDS, Thomas Arthur, B.SC., DIP. ED. (WALES)
(A) ROCHE, Rodney Sylvester, B.SC. (GLAS.)
(P) RYAN, Ann Elizabeth, B.SC., PH.D. (LOND.)
(OA) SIM, Wong Kooi, B.SC., DIP. ED. (MALAYA)
(X) STARKEY, Frederick
(E) WATKINS, David Kenneth, B.SC. (CARDIFF)
(D) WATT, Donald, B.SC. (DUNELM.)

GRADUATE MEMBERS ELECTED TO THE ASSOCIATESHIP

(L) BAXTER, Kenneth
(O) BLAND, Henry Horsfall, B.SC. (LIV.)
(P) CHAPMAN, John Derek
(P) COLLINS, John Frederick
(E) CRAWFORD, Henry Roy
(SS) EMMOTT, Paul, B.SC., PH.D. (LOND.)
(D) FAULKNER, John Keith, B.SC. (LOND.)
(N) FLESHER, Peter
(S) HAMMILL, Francis
(O) HARDING, George
(R) HARVEY, Neil Michael, B.SC. (LOND.)
HUDSON, Barrie, B.SC. (WALES)
(S) JENKINS, David Isaac, B.SC. (BIRM.)
(C) LEWIS, Michael John, B.SC., PH.D. (BIRM.)
(H) LEYSHON, Keith, M.SC. (LEIC.)
(O) LYON, John, B.SC. (DUNELM.)
(J) MACKAILL, Alan William, A.H.-W.C.
(Q) MAKINSON, George Kenneth, A.R.T.C.S.
(Q) MASSEY, Keith, A.R.T.C.S., B.SC. (LOND.)
(O) NESBITT, Donald Alexander
(O) PENTLAND, John Richard, B.SC. (LOND.), B.SC. (WALES), A.R.T.C.S.
(D) SAINSBURY, Malcolm, A.C.T. (BRIST.)
(S) SANDLER, Anita Michaelle
(Q) SMITH, Wilfrid Bernard, A.R.T.C.S.
(R) STENING, Theodore Charles, B.SC., PH.D. (LOND.), A.K.C.
(S) STEPHENSON, George William, M.SC. (DUNELM.)
(Q) TETLOW, John Alan, A.R.T.C.S.
(P) TICE, Philip Arthur, B.SC. (LOND.)
(P) TOWNSEND, Ronald Jefferson, B.SC. (LOND.), DIP. ED. (MANC.)
(SS) WALLWORK, Roy, B.SC.TECH. (MANC.), A.M.C.T.
(D) WILLIAMS, Leonard
(P) RILEY, Peter Bernard, B.SC. (BIRM.)

NEW GRADUATE MEMBERS

(Q) AINSCOW, Robert Vernon
(K) BAILLIE, Matthew James, A.R.C.T.S. (GLAS.)
(Q) BANNISTER, William David, A.R.C.T.S.
(O) BIRTWISTLE, Robert
BORTON, Brian Roger
(S) BRAVEY, John
(N) BROWNE, Anthony Arthur Briarly, B.SC. (LOND.)
(U) BULLEY, Victor Stephen
(SS) CHADWICK, Derek
(P) CHOWN, James Philip
(J) COLLIER, John Brian
(C) COOPER, Herbert Terence
(O) CREASER, Leonard Francis
(D) DICKES, Geoffrey James
(P) DUNNING, Leonard Alfred
(H) EVANS, Robert Gibson
(WW) FALCONER, Agnes Jack, B.SC. (EDIN.)
(Q) FRANKEL, Eric
(C) FREEMAN, Sidney William
(S) GARDINER, William
(N) GARFORTH, John David
(V) GILBERT, James Raymond, B.SC. (WALES)
(P) HAYMAN, David Frank
(SS) HILSON, Matthew Anthony
(S) HOPPER, John Edward
(S) JOHNSTON, David George
(O) JONES, John Arnold
(P) JONES, Michael Edward Benet, B.SC. (SHEFF.)
(U) JUKES, Clifford
(P) JUNIPER, Ian Robert
(P) KELLOND, Dennis Albert
(S) LAWS, John
(C) LEMMON, Terence Brian
(P) LIMON, Clive Robert
(P) LUCAS, Raymond Arthur
(K) MCKAY, Robert Bruce, B.SC. (GLAS.)
(P) MOSS, Arthur Donald, B.SC. (WALES)
(Y) O'BRIEN, Kevin Bernard
(R) OSBORNE, David Richard Duke
(P) PETTITT, David John
(Y) PLUNKETT, Arthur Owen
(X) PUGH, Leonard Keith
(R) RAYNER, Graham Harry
(A) REID, John
(T) ROBERTS, Alyn Griffiths
(T) ROBERTS, Ryland James
(X) ROBSON, George Peter
(X) SHEPHERD, Tom
(C) SIDWELL, James Harry
(V) SMITH, Graham Arthur Leroy
(O) SMITH, Joseph
(Y) SMYTH, Michael James
(N) SQUIRE, Keith Harvey
(K) TAYLOR, Robert Bannatyne, B.SC. (GLAS.)
(E) TELLING, Geoffrey Morgan
(P) THOMAS, Thomas John
(B) THOMPSON, Ronald Hugh
(C) WEBLEY, Gordon Roy, B.SC. (LOND.)
(T) WILLIAMS, Alun
(O) WOLSTENHOLME, Jack, M.SC. (LIV.)
(X) WOODHOUSE, Peter William
(C) YARWOOD, Eric Thomas, DIP. TECH. (BIRM.), A.C.T. (BIRM.)

CHANGE OF NAME ON MARRIAGE

Brigid KELLY to CUMMINS, *Associate*

DEATHS

Fellows

(P) BARRS, Charles Edward. Died 25 June, 1960, aged 80. *A.* 1918, *F.* 1924.
(C) CHEKE, Thomas William. Died 12 June, 1960, aged 75. *A.* 1905, *F.* 1921.
(P) ELSDEN, Alfred Vincent, O.B.E., B.SC. (LOND.) Died 15 July, 1960, aged 80. *A.* 1903, *F.* 1906.
(FF) KEILLER, Patrick Anderson. Died May, 1960, aged 80. *F.* 1927.
LEEMANN, Walter Gustav, M.SC. ENG. (RAND), DR. ING. (CHARLOTTENBURG) Died 4 March, 1960, aged 62. *A.* 1933, *F.* 1946.
(D) LEWIS-DALE, Percy, B.SC., PH.D. (LOND.) Died 8 July, 1960, aged 82. *A.* 1920, *F.* 1923.
TAYLOR, Norman, B.SC. (MANC.) Died 15 February, 1960, aged 74. *F.* 1918.

Associate

(B) THOMPSON, Martha Henrietta, B.SC. (N.U.I.) Died June, 1959, aged 55. *A.* 1928.